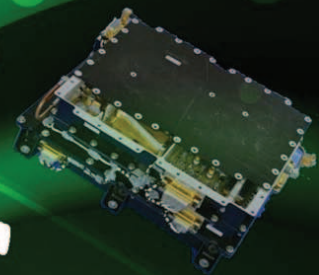




Enabling Spacecraft Systems Realization Through Industries (ESSRI-2017)



Souvenir



14 JULY 2017



ISRO SATELLITE CENTRE
BENGALURU-560017



Souvenir

ESSRI 2017

ENABLING SPACECRAFT SYSTEMS REALIZATION
THROUGH INDUSTRIES

ISRO SATELLITE CENTRE
BENGALURU

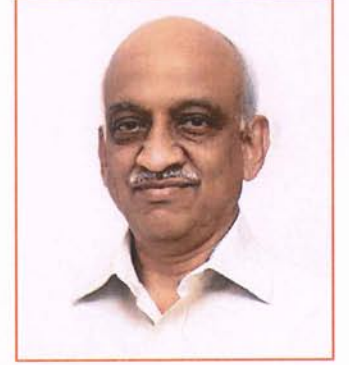
भारतीय अन्तरिक्ष अनुसंधान संगठन
अन्तरिक्ष विभाग
भारत सरकार
अन्तरिक्ष भवन
न्यू बी ई एल रोड, बेंगलूर - 560 231, भारत
दूरभाष : +91-80-2341 5241 / 2217 2333
फैक्स : +91-80-2341 5328



Indian Space Research Organisation
Department of Space
Government of India
Antariksh Bhavan
New BEL Road, Bangalore - 560 231, India
Telephone: +91-80-2341 5241 / 2217 2333
Fax : +91-80-2341 5328
e-mail : chairman@isro.gov.in

आ. सी. किरण कुमार / A. S. Kiran Kumar
अध्यक्ष / Chairman

MESSAGE



Space based services in the areas of communication, navigation, remote sensing, meteorology and disaster management have become a mainstay for the national development. Ensuring continuity of these services and addressing the emerging space applications is leading to growing demand for end-to-end spacecraft systems realisation by involving the Indian industry.

Space systems realisation through Indian industry is poised to benefit both ISRO and the Industry. While the trained and skilled manpower resources of ISRO can be engaged in cutting edge R&D, industry partners can build their technological capabilities to facilitate their diffusion into other areas of national technological endeavours besides providing them competitive edge.

In this scenario, it is heartening to note that a Seminar on Enabling Spacecraft Systems Realization through Industries (ESSRI-2017) is being organized at ISRO Satellite Centre (ISAC), Bangalore on 14th July 2017.

I hope the outcome of the seminar deliberations will pave way for increased industry participation in ISRO programmes.

I wish the seminar all success.

आ सी किरण कुमार
(आ. सी. किरण कुमार)
(A. S. Kiran Kumar)

Bangalore
July 11, 2017

भारत सरकार
अंतरिक्ष विभाग
इसरो उपग्रह केन्द्र
पोस्ट बॉक्स नं. १७९५, हवाई पत्तन मार्ग
विमानपुरा डाक घर, बेंगलूर - ५६० ०१७. भारत
दूरभाष : + 91 80 2520 5252
+ 91 80 2508 2102
फैक्स : + 91 80 2520 5251



Government of India
Department of Space

ISRO Satellite Centre

Post Box. No. 1795, Airport Road, Vimanapura Post
Bangalore - 560 017, India
Telephone : + 91 80 2520 5252
+ 91 80 2508 2102
Fax : + 91 80 2520 5251

डॉ. एम. अण्णादुरै
Dr. M. ANNADURAI
निदेशक / DIRECTOR



MESSAGE

Since 1975 till date ISRO Satellite Centre has built more than 90+ Satellites with wide spectrum of technologies for various applications.

The Indian Space Programme is undergoing a phenomenal change in promoting active participation of Indian Industries in space sector in a big way. Currently Industries are supporting in the fabrication and testing of spacecraft subsystems. Recently, Contract was awarded to a consortium of Industries for Assembly, Integration & Testing of Standard ISRO Satellite. The Centre is fully equipped with state-of-the-art facilities for fabrication and testing of mechanical and electronic hardware/subsystems and integrated satellite which can be used by the industries also.

Besides these many technology development programmes in various technology domains that are required for future satellite projects are being pursued in the Centre. ISAC is gearing up to build more than 12-18 satellites per year to meet the national demands from various users.

Enabling Spacecraft subsystems realization through Industries (ESSRI)-2017 is an ideal platform for the Industries and ISRO to come together in the space sector.

I wish the ESSRI - 2017 Seminar a grand success.

एम. अण्णादुरै

डॉ. एम. अण्णादुरै

(Dr.M. ANNADURAI)

भारत सरकार
अंतरिक्ष विभाग
विक्रम साराभाई अंतरिक्ष केंद्र
तिरुवनंतपुरम - 695 022, भारत
दूरभाष : 0471-2704412 / 2565567
फैक्स : 0471-2704105
ईमेल : director@vssc.gov.in



Government of India
Department of Space
Vikram Sarabhai Space Centre
Thiruvananthapuram - 695 022, India
Phone : +91-471-2704412 / 2565567
Fax : +91-471-2704105
Email : director@vssc.gov.in
k_sivan@vssc.gov.in

डॉ के. शिवन/Dr. K. SIVAN
विशिष्ट वैज्ञानिक व
Distinguished Scientist &
निदेशक/Director



MESSAGE

It gives me great pleasure to note that ISRO Satellite Centre (ISAC) along with Society of Indian Aerospace Technologies and Industries (SIATI) is organizing a seminar on "Enabling Spacecraft Systems Realisation through Industries [ESSRI 2017]. The increasing momentum of Indian Space scenario with respect to increase launches along with higher throughput in terms of satellites aims for a rapid increase in utilization of space based services for nation's socio-economic development. This also presents a host of opportunities for Indian Industries to join hands with ISRO in meeting the country's increased demand for satellites and related technologies.

I am sure that this seminar would provide a perfect platform for developing more industrial partnerships and projects leading to larger capacity utilization in the industries. I look forward to greater ISRO-Industry partnership through this seminar by sharing the best practices, skills and expertise residing across various domains.

I wish ESSRI 2017 all success.

K. Sivan
11/11/2017
(K. SIVAN)



तपन मिश्रा

निदेशक

Tapan Misra
Director



सत्यमेव जयते

भारत सरकार GOVERNMENT OF INDIA
अंतरिक्ष विभाग DEPARTMENT OF SPACE
अंतरिक्ष उपयोग केंद्र
SPACE APPLICATIONS CENTRE
अहमदाबाद AHMEDABAD - 380 015
(भारत) (INDIA)

दूरभाष PHONE : +91-79-26913344, 26928401

फैक्स /FAX : +91-79-26915843

ई-मेल E-mail : director@sac.isro.gov.in



MESSAGE

ISRO has been at the forefront of innovations in Space Technology for societal applications. Various technologies developed by ISRO have rendered several successful missions. It has led to the self reliance in design and development of spacecraft, launch vehicles and ultimately harnessing space applications for national development in key sectors.

The Indian industry has also come a long way by developing technical skills, capabilities and resources. The ever increasing demands for space based services is leading to a scenario where synergy between ISRO and industry partners is required to be identified for meeting spacecraft production goals. Spacecraft production offers opportunities for industry in various domains such as avionics, mechanical systems, electro-optical systems, inertial systems, composites, etc. It is high time that ISRO and industries extend greater co-operation and leverage each other's strengths.

At this crucial juncture when ISRO is embarking on a journey of pursuing next generation challenging technologies, I am delighted to note that a seminar on "Enabling Spacecraft Systems Realization through Industries (ESSRI-2017)" is being organized at ISRO Satellite Centre, Bangalore. This seminar would definitely bring different stakeholders in the spacecraft production value chain together and the deliberations would go a long way in developing a strong ISRO-Industry relationship.

My best wishes for the seminar.

Place: Ahmedabad

Date: 10 July 2017

तपन मिश्रा

(तपन मिश्रा)

(Tapan Misra)

भारत सरकार
अंतरिक्ष विभाग
सतीश धवन अंतरिक्ष केन्द्र शार
श्रीहरिकोटा रेंज डा.घ. - 524 124
श्री पोट्टि श्रीरामुलु नेल्लूर जिला (आं.प्र.) भारत
टेलीफोन : + 91 - 8623 - 225050
+ 91 - 44 - 25364450
फैक्स : + 91 - 8623 - 225152
ई-मेल : director@shar.gov.in



Government of India
Department of Space
Satish Dhawan Space Centre SHAR
Sriharikota Range P.O. - 524 124
Sri Potti Sreeramulu Nellore Dist. (A.P.) India
Telephones : + 91 - 8623 - 225050
+ 91 - 44 - 25364450
Fax : + 91 - 8623 - 225152
E-mail : director@shar.gov.in

पी. कुन्हीकृष्णन P. Kunhikrishnan
निदेशक Director



MESSAGE

The complexity in design and compulsion to function reliably necessitate intense research drive to develop the spacecraft systems. The increased launch frequency in recent times demands a long term, full scale tie-up between R&D organizations and industries. This will ensure implementation of advanced manufacturing technologies for massive, timely and continuous flow of deliverables. The relationship between ISRO and industry will soon transcend from symbiotic to complementary.

I compliment ISRO Satellite Centre (ISAC) and Society of Indian Aerospace Technologies and Industries (SIATI) for jointly organizing a seminar on **"Enabling Spacecraft Systems Realization through Industries (ESSRI-2017)"** on 14th July 2017. ISAC is a nodal Centre for ISRO responsible for the realization of a variety of spacecrafts and SIATI is working tirelessly since 1991 for the upliftment of Indian Aerospace Industries. It is indeed a great pleasure to see them join hands with each other to host this seminar.

This seminar will serve as a platform for ISRO to introduce a host of manufacturing avenues for the industries pertaining to the spacecraft systems realization; and industries, in turn, will share their capabilities and specialties. I am sure that the participants from both ISRO and industries will take home wealth of knowledge from this seminar.

My good wishes to the organizers.

(P Kunhikrishnan)
Director

भारत सरकार
अंतरिक्ष विभाग
द्रव नोदन प्रणाली केंद्र
वलियमला पोस्ट
तिरुवनंतपुरम - 695 547, भारत
दूरभाष : 0471 2567257/2567554
फैक्स : 0471 2567242



Government of India
Department of Space
Liquid Propulsion Systems Centre
Valiamala P. O.
Thiruvananthapuram - 695 547, India
Telephone : 0471 2567257/2567554
Fax : 0471 2567242

एस सोमनाथ/S. Somanath
निदेशक/Director



MESSAGE

It is heartening to note that a Seminar on Enabling Spacecraft Systems Realization through industries (ESSRI-2017) is being organized at ISRO Satellite Centre, Bangalore. As ISRO embarking on major expansion in the sectors of communication, earth observation & navigation satellite systems, greater industry participation in spacecraft production is the way forward and this seminar address the key elements by ISRO & industry partners.

In my opinion, this seminar is poised to be a very significant event for our space program because it aims to harness the capabilities of industries to meet satellite production goals. I hope the deliberations in this seminar will pave way for enhancing industrial participation to produce highly reliable satellite systems on an end to end basis. I would request the scientific community and industry leaders to leverage this opportunity and contribute to national development.

On behalf of Liquid Propulsion Systems Centre (LPSC) and on my own behalf, I extend best wishes to the organizers and participants of this seminar.

[S. SOMANATH]

July 10, 2017

भारत सरकार
अन्तरिक्ष विभाग
विद्युत - प्रकाशिकी तंत्र प्रयोगशाला (लियोस)
पहला क्रॉस, पहला स्टेज, पीण्या औद्योगिक एस्टेट
बेंगलूर - 560 058. भारत
दूरभाष : +91-80-28396470, 28371286-87
फैक्स : +91-80-28392304
A.S. LAXMIPRASAD
Director



Government of India
Department of Space
Laboratory For Electro-optics Systems (LEOS)
1st Stage, 1st Cross, Peenya Industrial Estate,
Bangalore - 560 058. India
Telephone : +91-80-28396470, 28371286-87
Fax : +91-80-28392304



ISRO

MESSAGE

I am delighted that ISRO Satellite Centre (ISAC), Bangalore is organizing a seminar on 'Enabling Spacecraft Systems Realization through Industries (ESSRI-2017) on July 14, 2017. With the current ISRO's plans of launching greater number of spacecraft for the increased space application requirements for the country, spacecraft system production through the Indian Industries is the way forward.

Building the industry capability for space system production requires numerous activities such as identification of suitable industry partners, imparting specialized training and skill development in fabrication, assembly and testing etc., LEOS has been supporting ISAC in this direction by developing vendors for production of electro optical sensors and optics. I am sure this seminar would provide a unique platform for ISRO and industries to come to a common platform and hold deliberations for giving impetus to production plans and charting out a roadmap for delivering off-the-shelf systems.

I wish the organizers and participants a very fruitful session during this seminar.

10th July 2017


[A.S..LAXMIPRASAD]

भारत सरकार
अंतरिक्ष विभाग

इसरो जड़त्वीय प्रणाली यूनिट

वट्टियूरकाव पी.ओ

तिरुवनंतपुरम -695 013

दूरभाष : +91(471)2361933/2569333

फैक्स : +91(471) 2361973

ई-मेल : iisu_director_office@vssc.gov.in



Government of India
Department of Space

ISRO Inertial Systems Unit

Vattiyoorkavu P.O.

Thiruvananthapuram-695 013

Telephone: +91(471)2361933 / 2569333

Fax: +91(471)2361973

e-mail: iisu_director_office@vssc.gov.in

डी. साम दयाल देव / D. Sam Dayala Dev

उत्कृष्ट वैज्ञानिक / Outstanding Scientist

निदेशक /DIRECTOR



MESSAGE

I am extremely happy to note that ISRO Satellite Centre, Bangalore is conducting a seminar on "Enabling Spacecraft Systems Realization through Industries (ESSRI-2017)" aimed at enhancing the contribution of Indian industries to ISRO's programmes.

Over the years ISRO has developed many cutting edge technologies. The space products design and fabrication are through well-established processes to meet aerospace standards and have been successful in several past missions of ISRO. However, ISRO is now embarking on very ambitious program to meet the national demands for space infrastructure. IISU also is exploring licensed production of inertial sensors by Indian industry to meet the increasing demands. This presents an opportunity for Indian industry to meet the end to end demand for sensors and systems realization. I hope this seminar will provide opportunities for strategic planning to meet the above goal and overcome limitations, if any.

I extend my sincere greetings and best wishes to the organizers for the successful conduct of the seminar.

July 10, 2017

(D SAM DAYALA DEV)



**Jawaharlal
Advanced**
Jakkur P O

**Nehru
Scientific**

**Centre for
Research**
Bangalore 560 064, India

Prof Roddam Narasimha, FRS
DST Year-of-Science Professor
Engineering Mechanics Unit

12 July 2017

MESSAGE

With its growing fleet of communication, remote sensing and navigation satellites, the moon and Mars missions and its ability to offer affordable launches of multiple small satellites, ISRO has now carved a unique place for itself in the global space arena. But this remarkable expansion in its space programme, and the advent of GSLV MKIII with our own cryorockets, has led to great pressure on the technical and human resources of ISRO. The exploitation of these distinctive advances that India is making in cutting-edge R&D in space calls for a new initiative, which may be described as the beginning of the 'industrialization' of space technology in India. ISRO's relations with industry are already strong, but the time has come to take the next important step of transforming the relationship from what started as that between buyers and vendors to one between mutually supportive partners, by way of transfer of technology and experience from ISRO and of manufacturing, business and even design skills in certain areas from industry. As ISRO expands its horizons by the successful development of new technologies, so the time has come for industry play a bigger role in the Indian space enterprise.

Indian industry has already demonstrated its tremendous capability to handle complex projects in the aerospace domain. With the new initiative I am sure that industry can add great value to the nation's space applications programmes, and create new wealth from advanced technology.

I am delighted to note that ISRO Satellite Centre and SIATI, both at Bengaluru, have identified these emerging needs and are organizing a seminar on "Enabling Spacecraft Systems Realization Through Industries" (ESSRI-2017) - a most appropriate theme for exploiting the new opportunities that are now before us. I hope this seminar helps in building new bridges between ISRO expertise and industry capabilities, and will take India's space programmes to greater heights and enhance the economic value of the growth trajectory that ISRO has been charting out over the decades.

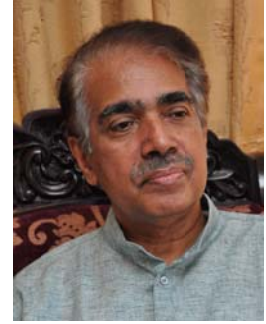
I wish the Seminar all success.

(Prof. Roddam Narasimha)

SIATI



Dr. C.G. Krishnadas Nair
Former Chairman, HAL,
Hony. President,
Society of Indian Aerospace Technologies & Industries
AeSI Building, Suranjandas Road
Off: Old Madras Road, Bangalore – 560 075
Tel: 91-80-25275262/25219951; Fax: 91-80-25292440
E-mail: cgkn@siati.org; Website: www.siati.org



Message

As Honorary President, SIATI, I would like to congratulate the Chairman of ISRO and Director, ISAC and the team ISRO-ISAC for their tremendous achievements, including the world record of launching the largest number of satellites in a single launch. The Satellite Centre has contributed much by designing and developing several types of advanced satellites for communication, remote sensing, telemedicine, tele-education and may more.

This is the Silver Jubilee year of SIATI, which was founded 25 years ago with the initiative of HAL and ISRO to involve Indian industries, particularly small and medium sector in developing and manufacturing components and systems for the Indian aerospace projects. We have come a long way and we can feel proud of our success in enhancing self-reliance in aircraft and space projects, through partnership. ISRO Satellite Centre has played a significant role in nurturing industries as reliable supply chain partners and also as R&D partners for innovation. This seminar is organized by ISAC & SIATI with the noble objective of “*Enabling Spacecraft Systems Realisation through Industries*”.

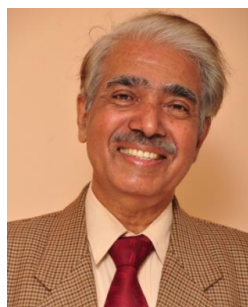
We have a large number of industry participants and I wish them continued success in stepping up their participation both as innovators and supply chain partners. Individually you are excellent and are making excellent contributions. However for greater contributions **TEAM WORK** among you, forming consortium and sharing responsibilities is very important. I wish you to have excellent networking during the seminar and move ahead with team work to achieve greater success.

(Dr.CG.Krishnadas Nair)
Hony. President, SIATI

Dtd. 11th July 2017



Society of Indian Aerospace Technologies & Industries (SIATI)



Dr.C.G.KRISHNADAS NAIR
FOUNDER

“**Our mission** is the growth of aerospace infrastructure and capabilities in India, Creating useful interaction among Indian and International aerospace industries, R&D, academia , Quality and Regulatory agencies for development and production of aircraft materials, components, structures, equipments and systems, Enhancing private industry participation with special focus on SMEs and International Co operation for the benefit of all concerned, developing global opportunities, greater employment, wealth and welfare ”

ACHIEVEMENTS- SIATI

Society of Indian Aerospace Technologies & Industries (SIATI) was established in the year 1991 with the support of major aerospace organisations such as HAL/ISRO/DRDO/NAL/DGCA/ CEMILAC and DGAQA with a mission to create useful interaction with Indian and International Aerospace companies, R&D organisations for growth through partnership, creating useful interaction among Indian and international Aerospace Industries, R&D, Quality & Regulatory agencies for development and production of aircraft, materials, components, structures, equipments and systems and enhancing participation of the Indian private industries with special focus on SMES and growing global opportunities for synergising private industries with aerospace and defense PSUs, R&D organisations.

For more than two decades, SIATI has been serving the Nation and is happy to state that SIATI has made substantial progress over the years in harnessing the potential of its member industries for developing & manufacturing aerospace materials, components, equipments and systems and also information technology, enhanced design and testing solutions. It has also inspired and nurtured several SMEs in different regions in India to actively participate in the aerospace and defence sector R&D and Manufacture, enhancing self-reliance.

Workshops: SIATI has been conducting every year a number of awareness workshops and seminars on the business opportunities for the Indian SMEs and private sector based on the national aerospace and defence projects and also arising out of a offset opportunities

Training: SIATI has conducted several training workshops on the subjects useful to its member companies such as procedure for indigenisation, equipment required to be indigenously developed, associated technologies, certification requirements and the like.

Exhibitions: Several exhibitions have been organised from time to time indicating the requirement of the Indian Aerospace and Defense industries and also spare parts requirement of the armed forces.

Offset Policy: The Defense offset policy has come into existence due to consistent efforts of SIATI along with HAL. It is a matter of pride that SIATI has been always consulted for modifications and the improvements of the offset policy and many of our recommendations have been incorporated.

Air Show: SIATI has served the members by organising their participation in all the Aero India airshows and exhibitions held in Bangalore to show case members capabilities and arrange for visits to the stalls.

Industry Partners: We have advocated to the foreign OEMs and suppliers of equipments the need for taking Indian SMEs and other private industries as industry partners. It is a matter of pride that many Indian industries have become exporters of the Indian made aerospace components and equipments.

International Air Show: SIATI provided a gateway for international co-operation through participation in Indian and overseas Air Shows, exhibitions and seminars, exchange of industry delegations and B to B meetings and also in co-operation with similar aerospace industry associations of other countries. SIATI initiated the concept of “**India Pavilion**” in the international Air Shows and led Indian delegations to these Air Shows.

SIATI Awards: Excellence in R&D and innovations by members were recognised by bestowing ‘**SIATI Awards for Excellence in Indigenous Development**’. So far 153 industries have been honoured with SIATI awards.

Innovation & R&D: SIATI contributed in the development of private industries to be partners in innovation and R&D with HAL, ISRO, DRDO, BEL and other DPSUs, NAL and other R&D Labs. Many Indian Private Industries have also become exporters of Indian made aerospace and defense products to leading aerospace companies in the other countries.

Short Courses: SIATI conducted short-courses to impart knowledge and training personnel from industries to enhance their competence. These short courses are imparted along with International Institute of Aerospace Engineering and Management (IIAEM), established by SIATI along with Jain University with the support of Indian Institute of Science (IISc), ISRO, NAL, HAL and several other aerospace and aviation business corporate. The participants are awarded certificates.

The International Institute for Aerospace Engineering and Management (IIAEM): IIAEM was conceived by SIATI and established under the direction of a high level committee with Dr.K.Kasturirangan, Member Planning, Co. Chairman, Dr.CG Krishnadas Nair, President, SIATI as Co-Chairman and with members from aerospace industries both public and private sector. It is a matter of pride for SIATI that IIAEM in the last 5 years has grown and is offering specialised programs leading to graduate and post graduate degree in Aerospace Engineering. A number of short courses (two day, three day and the like) have been designed and are being regularly conducted for working executives, engineers and technicians by IIAEM jointly with SIATI.

Aviation Sector Skill Council: As the Government of India announced the policy for skilling technicians / engineers for various industries under the National Skill Council, SIATI took initiative to form an Aerospace and Aviation Sector Skill Council under the aegis of National Skill Development Corporation, Government of India. The aerospace skill council has been registered as Section-8 Company, with a governing council/board with Chairman HAL by designation as Chairperson, Hony. President, SIATI, and Hony. President BCCI and representatives of industries from major aerospace and aviation organisations and the large number of supply chain (component manufacturers, equipment manufacturers).

Civil Aviation: SIATI has been Member of Civil Aviation Aeronautics Promotion Advisory Council (CAPAC), Ministry of Civil Aviation. SIATI is a Member of the working group on defence equipment and aerospace chaired by Secretary (DP). SIATI is also a member of the Aerospace Task Force under Ministry of Industries, Government of Karnataka and regular meeting are held under the Chairmanship of Secretary Commerce and Industries.

Aerospace Directory: SIATI has published directory of its members. As you recall the First Airshow was conducted by SIATI jointly with HAL / Aeronautical Society and private sector in the year 1993. It was at that time the First Directory on Indian Aerospace Industries was prepared and published giving the list of a number of SIATI members and their capabilities. Subsequently, SIATI has been revising the aerospace directory from time to time and distributing during the airshows for creating greater awareness of our members’ capabilities.

Aeromag Asia: A bimonthly Magazine ‘AEROMAG ASIA’ is published in association with SIATI by Aerosun Media, wherein the activities of SIATI are highlighted. The events of SIATI and its members are published under SIATI news regularly. AEROMAG has become a prominent aerospace and defense magazine.

As a part of Silver jubilee year, SIATI has started holding CEO interaction meet bimonthly as COFFEE@SIATI along with a useful presentation.

SIATI is managed and led by SIATI Council which has nominated members from HAL, ISRO, DRDO, CEMILAC, DGCA, and NAL and from Private Industries. We have constituted empowered committees from members to specially address issues on subjects such as offset & other Government policies, training and certification, International Co-operation with aerospace Industries and Aerospace Industry Association in other countries, software systems and engineering.

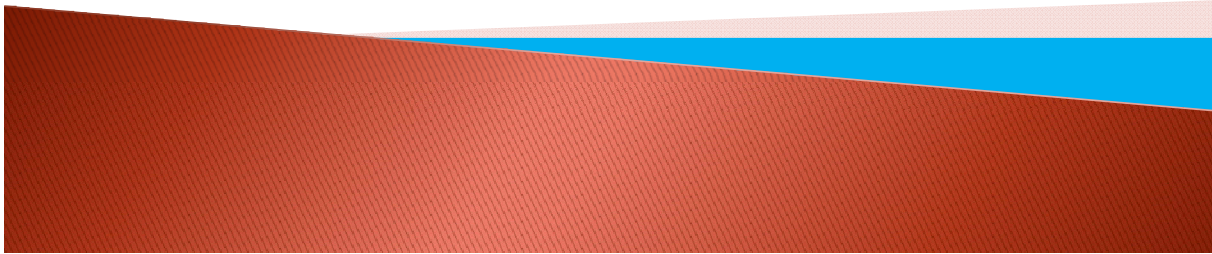
PRESENTATIONS

ISRO Vision



Bijay Kumar Behera

*Associate Director, Budget & Economic Analysis,
ISRO Headquarters*



Indian Space Programme

▶ Technological Capability

- Building Satellites for Communication, Earth Observation & Navigation
- Indigenous Launch Capability
- Lunar/Mars Missions
- Applications for socio-economic development

▶ Cost-effective space programmes

- Prioritisation & Optimisation
- Careful Planning & Execution

*(Optimized engine development programme,
common launch pad for all launch vehicles of ISRO)*

▶ Systematic Policy for Indigenization & Industrialization

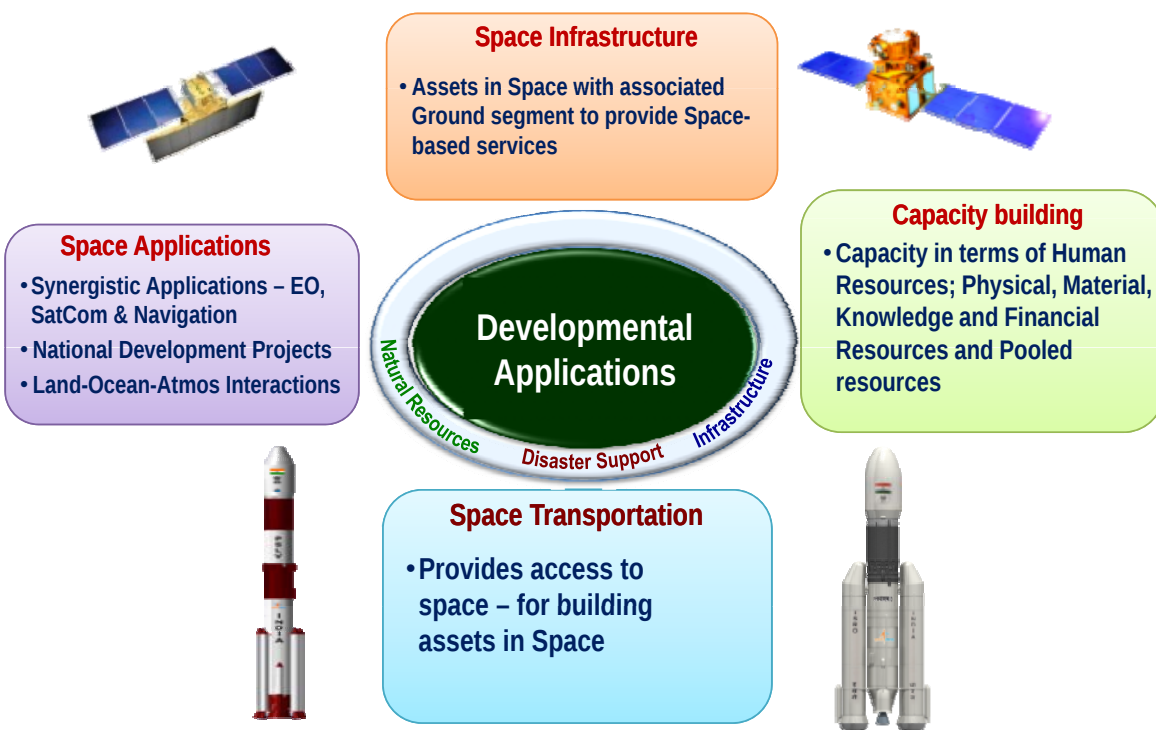
- Hand-holding & Technology Transfer
- Spin-offs

India in Space: Evolution and Achievements

- **Initiated in 1960's**
 - 1962 – INCOSPAR
 - 1969 – ISRO
 - 1972 - Space Commission & DOS
 - 1975 – Aryabhata Launched
- **Three National committees coordinate space system establishment & applications:**
 - INSAT Coordination Committee (ICC)
 - Planning Committee on National Natural Resources Management System (PC-NNRMS)
 - Advisory Committee for Space Sciences (ADCOS)
- **Realised 156 missions**
(90 Spacecrafts; 61 LVs; 5 TDs)
- **Three launch vehicles**
- **>40 Satellites in Orbit**
- **Annual budget: 1.4 billion USD**
- **Human Resources: 17,625**
- **State-of-the-art Infrastructure**
- **Strong Industry linkages (>500)**
- **International Cooperation and Commerce**
- **Space technology application expertise with large user base**

4 Verticals of Indian Space Programme

Vision: *Harnessing Space Technology for National Development*



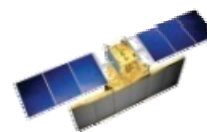
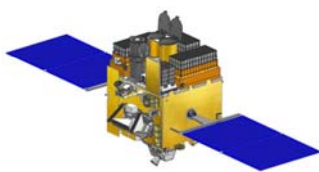
Space Transportation Systems

- Operational Launch Services - with increased frequency & enhanced Payload
- Development of Advanced Launch Vehicles
- Re-usable Launch Vehicle
- Low Cost Access to Space
- Human Spaceflight



Space Infrastructure

- Augmentation of Space Infrastructure
- Earth Observation with enhanced capability
- Satellite Communication – High-Throughput and Global Coverage Satellites
- NavIC – Regional to Global
- Space Sciences and Planetary Exploration



SPACE APPLICATIONS

SOCIO ECONOMIC SECURITY

- Food
- Water
- Energy
- Health
- Shelter
- Infrastructure
- Information



SUSTAINABLE DEVELOPMENT

- Impact Assessment
- Resources Conservation
- Ecosystem Management
- Climate Change Impacts
- Geo-sphere Bio-sphere

In Tune with Sustainable Development Goals (SDGs) envisaged by the Government

DISASTER RISK REDUCTION

- Preparedness
- Early Warning
- Response
- Recovery



GOVERNANCE

- Planning
- Monitoring
- Evaluation
- Decision Support

Capacity Building

- Human Resources Development
- Technical Infrastructure
- Enhanced Output through Outsourcing
- Indigenisation
- New Technologies – through Academia-Industry
- International Co-operation
- Outreach



Thank You...



**Productionisation of
subsystems to satellites
Requirements,
ongoing Activities & Future
Plan**



G. N. V. PRASAD

Deputy Director, ISRO Satellite Centre, Bengaluru

[ESSRI-2017]

Satellite Realization: Present Perspective



Growing **National Requirements**

Launch on Demand

Increasing Transponder need

Exponential Increase in Work Load

High Throughput Satellite

High Resolution Imaging Satellite

Interplanetary Mission Challenges

Thrust for R&D

International Co-operations

More than 12 Satellites per year

Productionisation of Subsystem

Vibrant Indian Industry Participation

Miniaturization of Subsystem

Zero Defect Systems

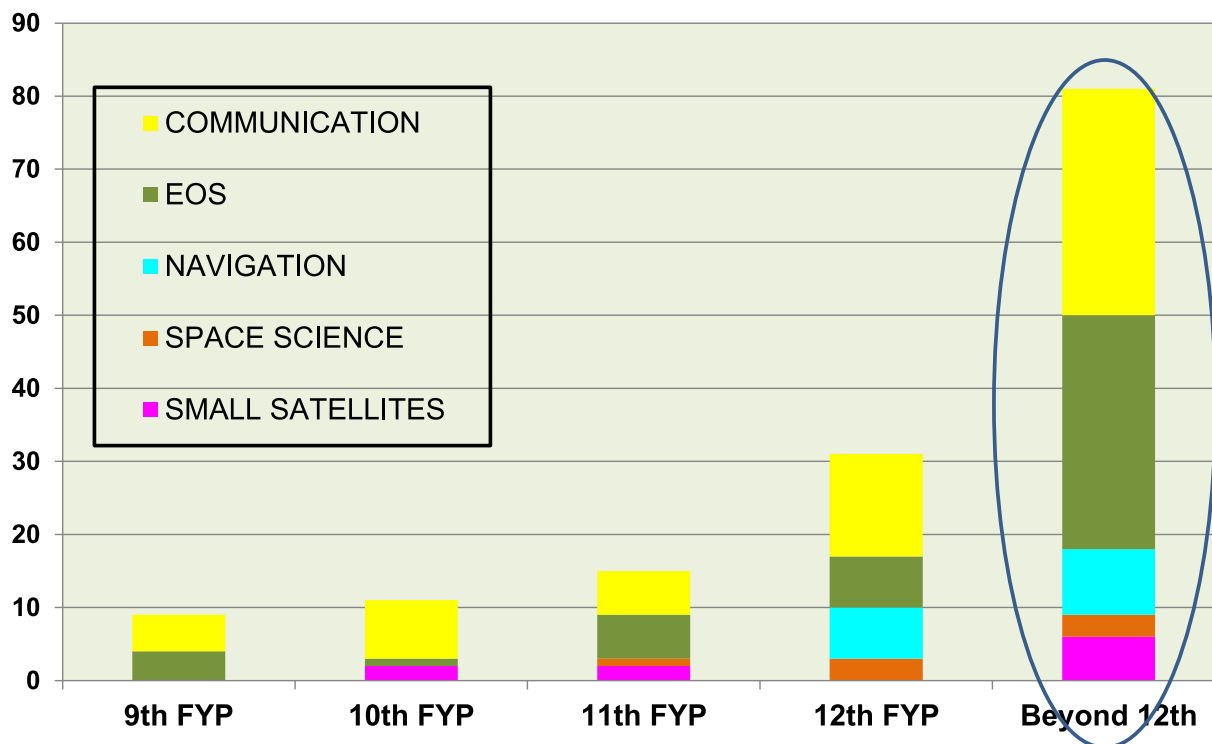
Infrastructure Buildup

end-to-end Outsourcing

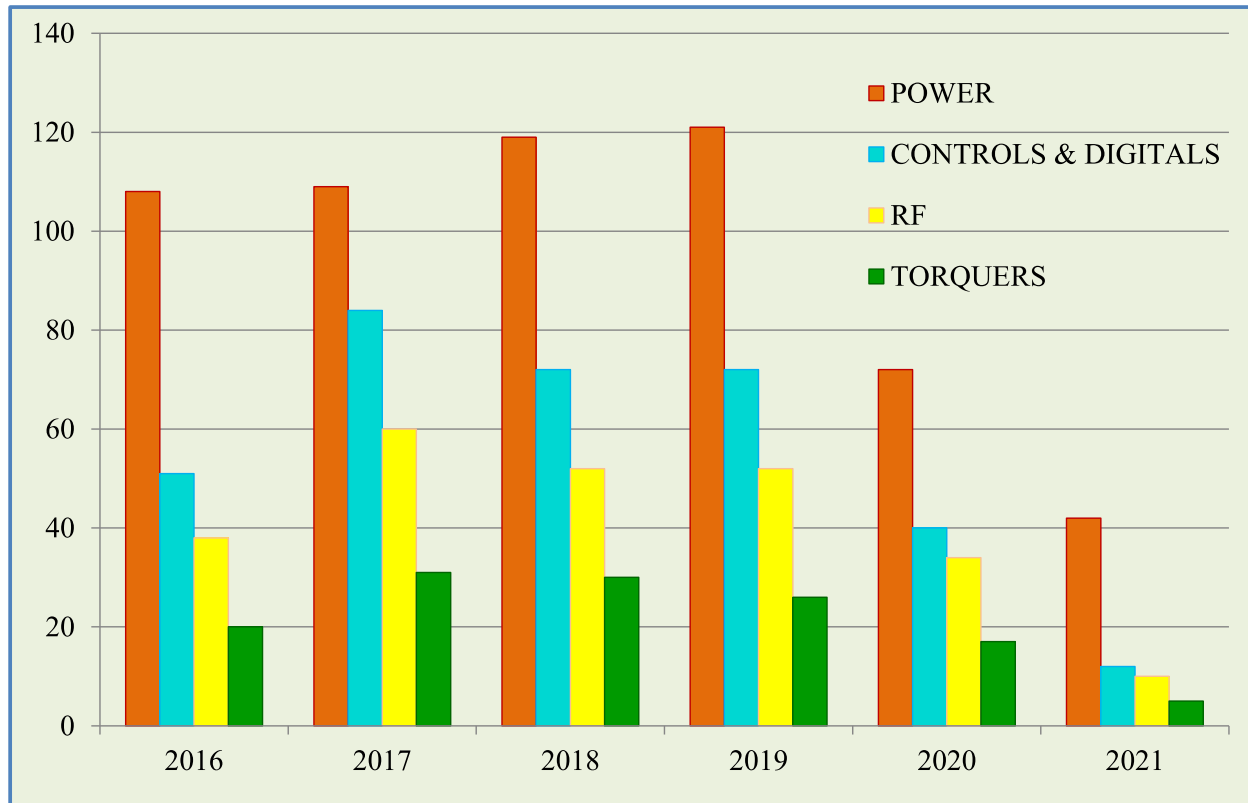
Tentative Satellite Manifest: 2017-2019

Programme	2017	2018	2019
Communication	GSAT-9 GSAT-19 GSAT-17 GSAT-11 GSAT-6A	GSAT-29 GSAT-20 INSAT-3DS GSAT-22 GSAT-23 GSAT-24 GISAT-1 GSAT-7A	GISAT-2 GSAT-25 GSAT-26 GSAT-27 GSAT-7C GSAT-30
Navigation	IRNSS-1H IRNSS-1I	IRNSS-1K IRNSS-1J	IRNSS-S1
Earth Observation	CARTOSAT-2D INS-1A INS-1B CARTOSAT-2E CARTOSAT-2ER INS-1C MICROSAT	EMISAT CARTOSAT-3 RISAT-2A RISAT-1A OCEAN-3 HYSIS	CARTOSAT-3A RES-3S HRSAT-1,2,3 OCEAN-3A RES-3 RES-3SA SPADEX
Space Science	CHAND-2		XPOSAT ADITYA-L1
Total	15	16	19

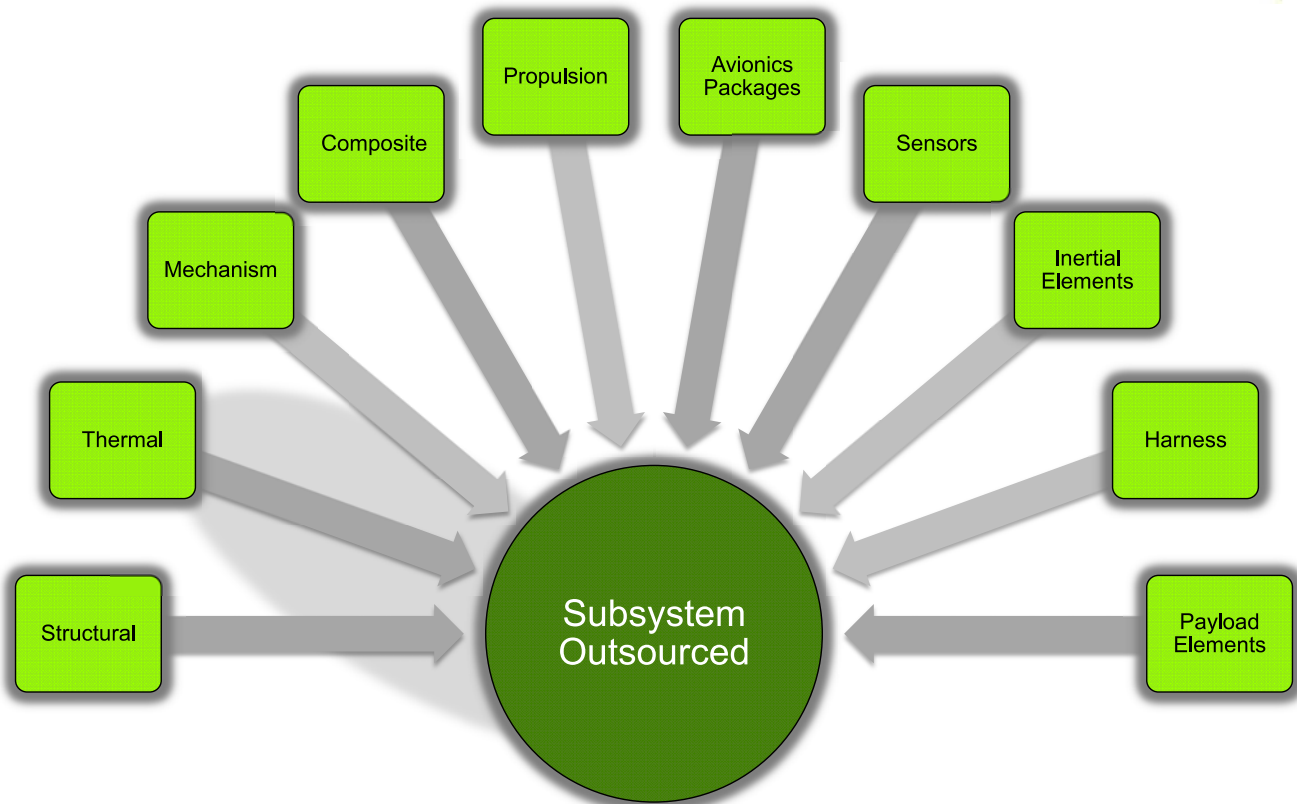
ISAC - Two Decades Plus – S/C Growth Trajectory



Anticipated Future Requirements –A Snapshot



Spacecraft Subsystems Outsourcing– Present Scenario





Mechanical system work flow process



Mechanical Systems

- spacecraft structure & structural elements
- Thermal control elements including heat pipes
- Thermal Implementation
- Sub-assemblies of solar array deployment mechanism & reflector deployment mechanisms
- Mechanical ground support equipment
- Design, modeling and analysis

ELECTRONIC SYSTEMS – PRODUCTIONISATION

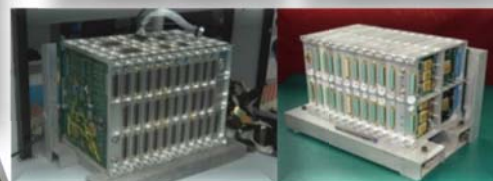
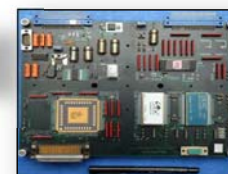
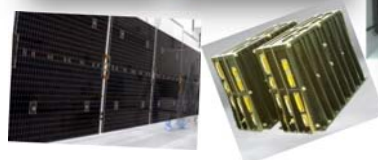


Electronic system work flow process

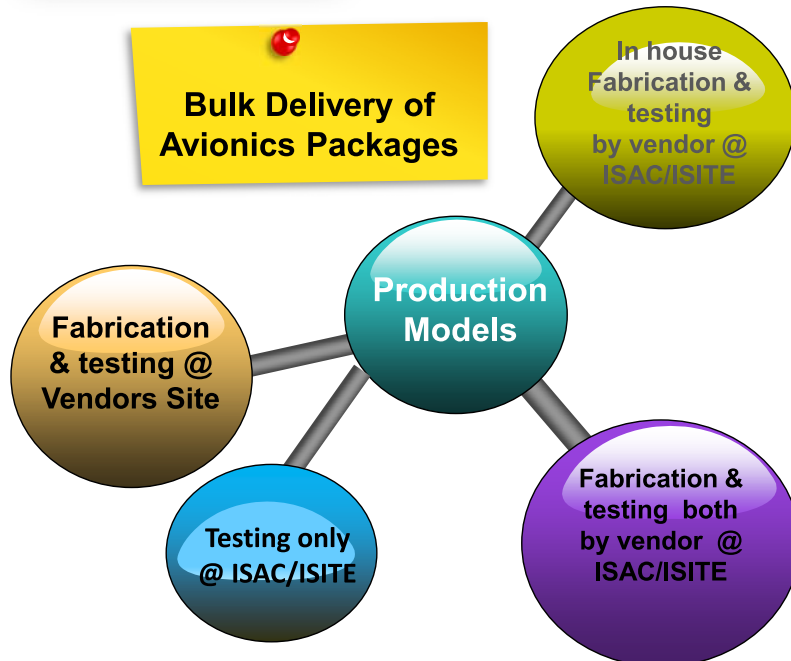


Electronic Systems under Productionisation

- Power Electronic Packages
- Control systems
- TMTC Packages
- RF systems
- DC-DC Converters
- Solar Panels
- Battery
- Magnetic Torquers
- HMCs & MMICs
- Harness Fabrication
- Test Systems
- Checkout Systems



Subsystem Productionization Efforts-Avionics



Infrastructure Augmentation



High Density Interconnect Facility



Avionics Production Building



Assembly, Integration Test Facility-2



Vibration Test Facility

Infrastructure Augmentation



Solar Panel & Battery Fabrication Facility



Mechanical System Area Block

- Advanced Heat Pipe Development Facility
- 29T Dynamic Test Facility
- 20T Dynamic Test Facility



Paint Booth Facility

Subsystem Production Initiatives

Industry Meet – Enabling Spacecraft Systems Realisation through Industries [June 2016] ESSRI:2017

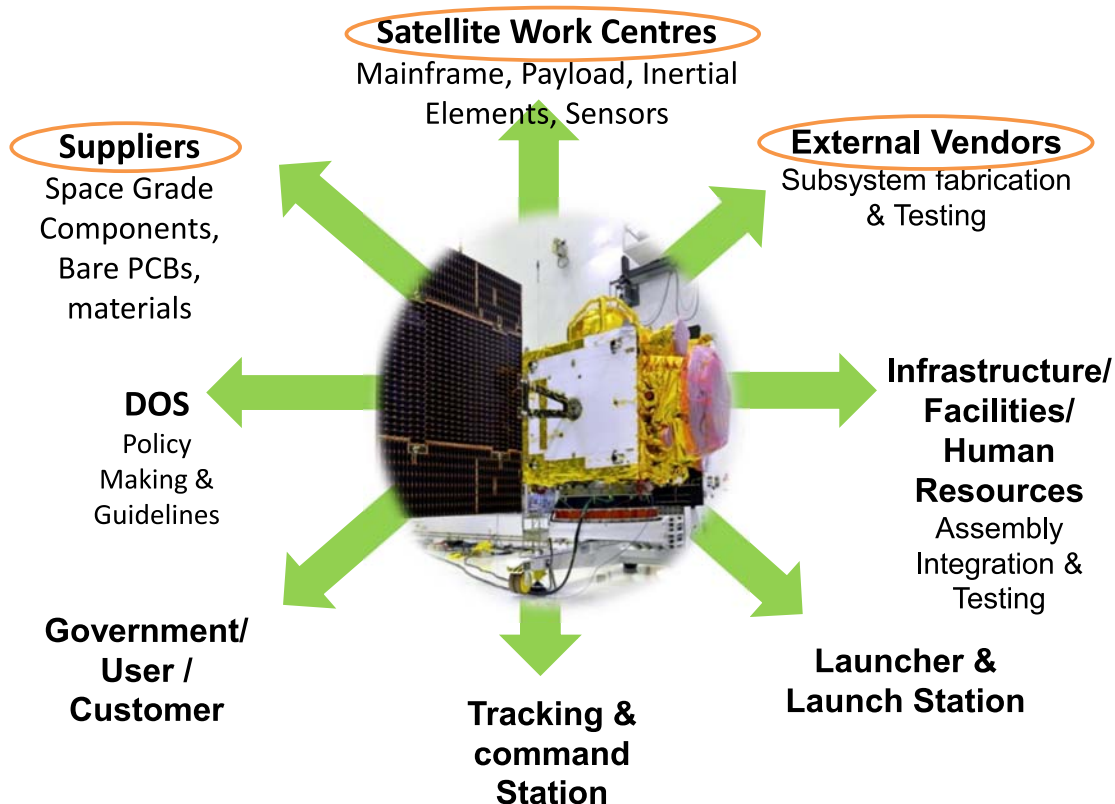


Conference on EEE Components for Space Applications



ISAC Vendors meet for E-procurement





Subsystem Outsourcing-Future Plan



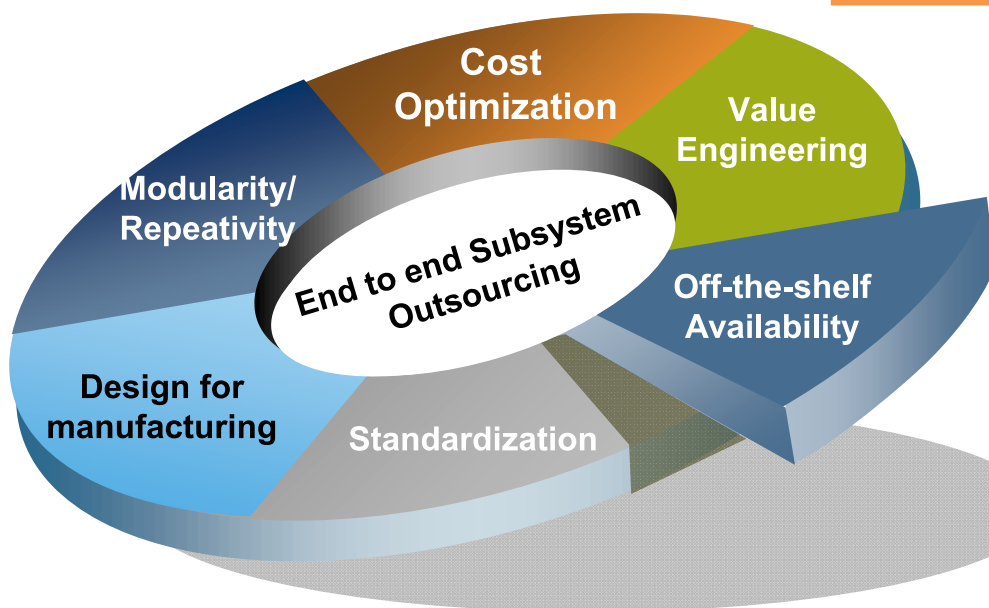
End to end outsourcing

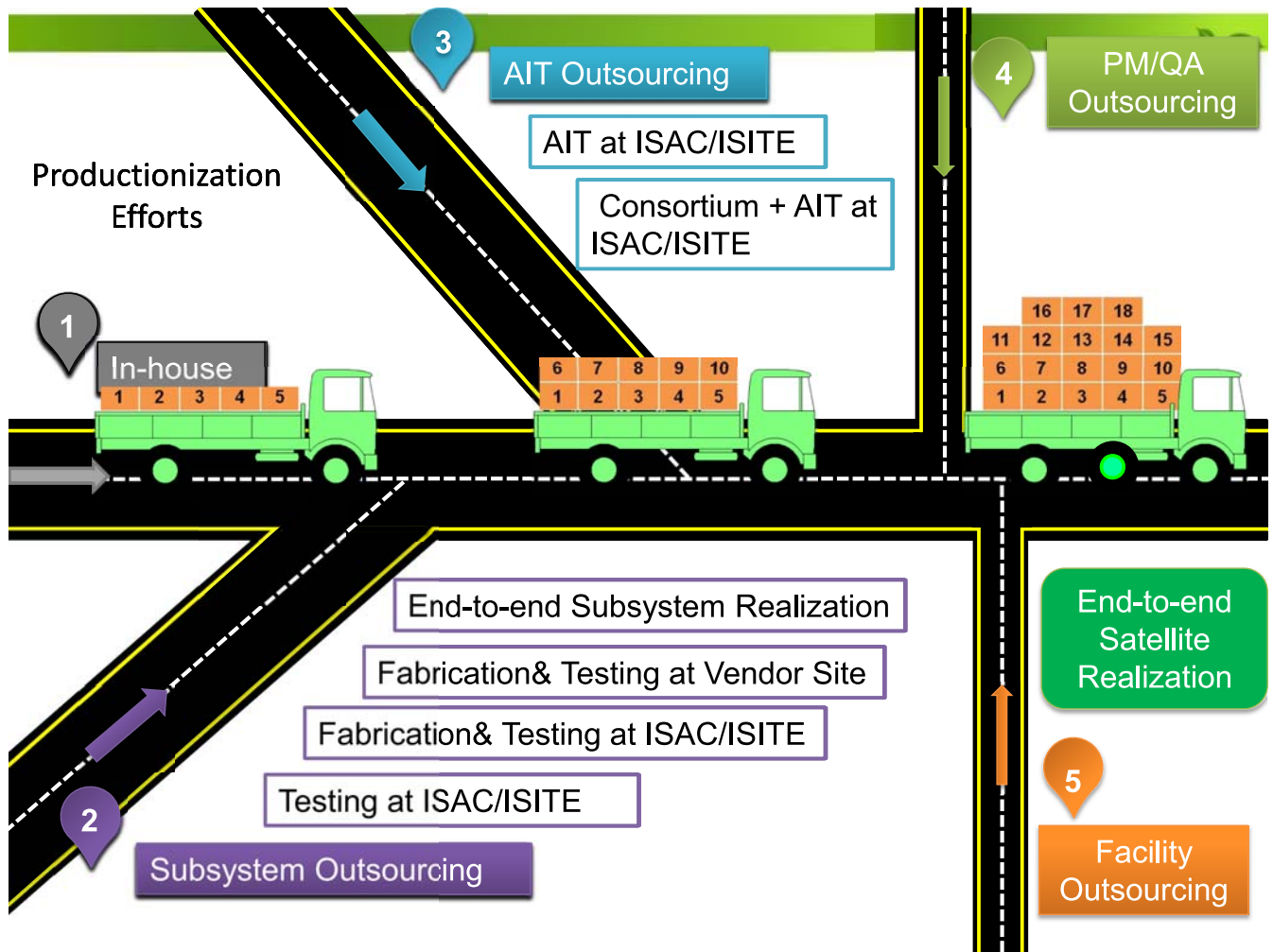
Component Procurement

Fabrication & testing

Environment Testing

Off-the-shelf Availability





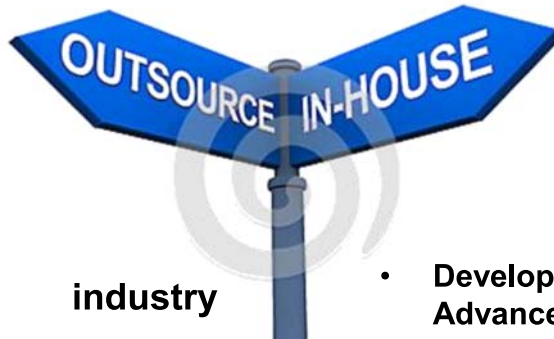
Strategy & Trends



Focus on Production

- Enhanced participation industry
- Off-the-shelf availability of Subsystem
- Fast Track realization of Satellite

ISAC



Strong Thrust on R & D

- Development of Satellite based Advanced Technologies for near future missions
- Dedicated Vision Group Team for identifying long term advanced technologies
- SPARK Committee – A platform programmed for young minds to come out with innovative ideas/ research proposals



THANK YOU



Conference on Enabling Spacecraft Systems Realization
Through Industries
ESSRI- 2017

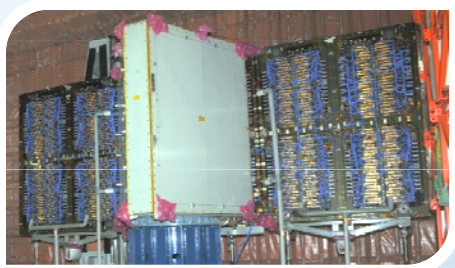
Vendor support for realization of Payload Systems

July 14, 2017

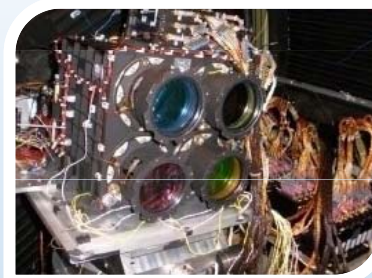
ISRO Satellite Centre
Bengaluru



THE PAYLOAD SYSTEMS



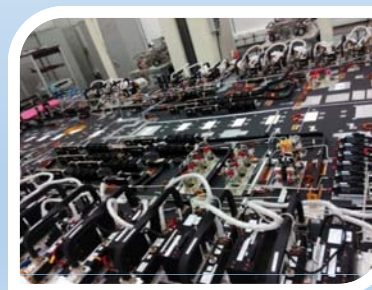
Microwave Earth Observation Payloads



Optical Earth Observation Payloads



Navigation Payloads



Communication Payloads



COMMUNICATION PAYLOAD BUILDING BLOCKS



Antenna



DGR Antenna

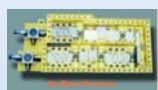


Sectoral Antenna



Prime focal Receive Antenna

Front End



Ku-band receiver tray



C-band receiver assembly

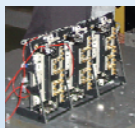


Pre-select Filter

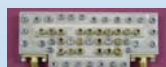


Rx-Rx Diplexer

Receive Channelization



C-band IMUX



Ku-band IMUX filter



Pre-select filter



Hybrid combiner

Channel & Power Amplification



C-band TWTA



15W C-band SSPA



EPC



Ku-band Driver Amplifier

Tx Section Filtering & Multiplexing



Ku-band OMUX



Harmonic Reject filter



Harmonic Reject filter

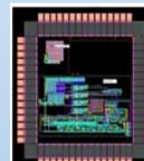
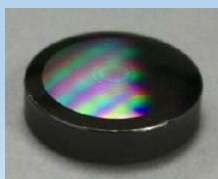
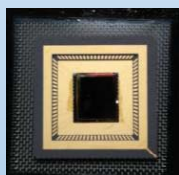
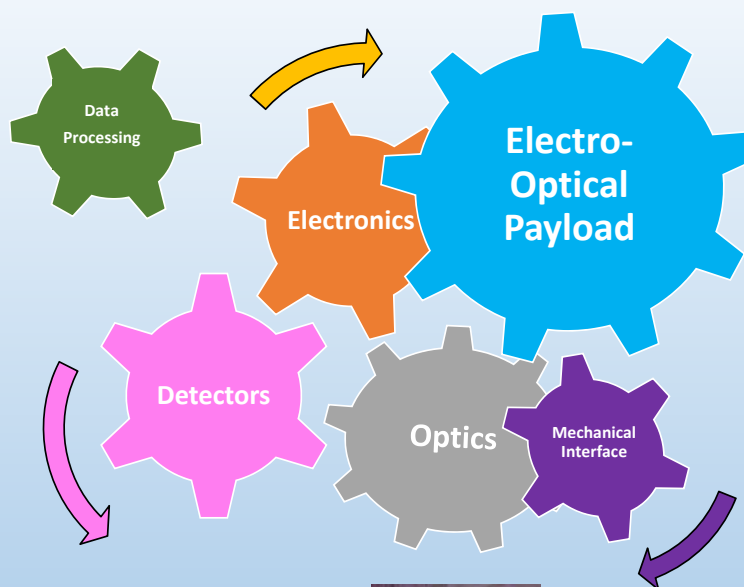


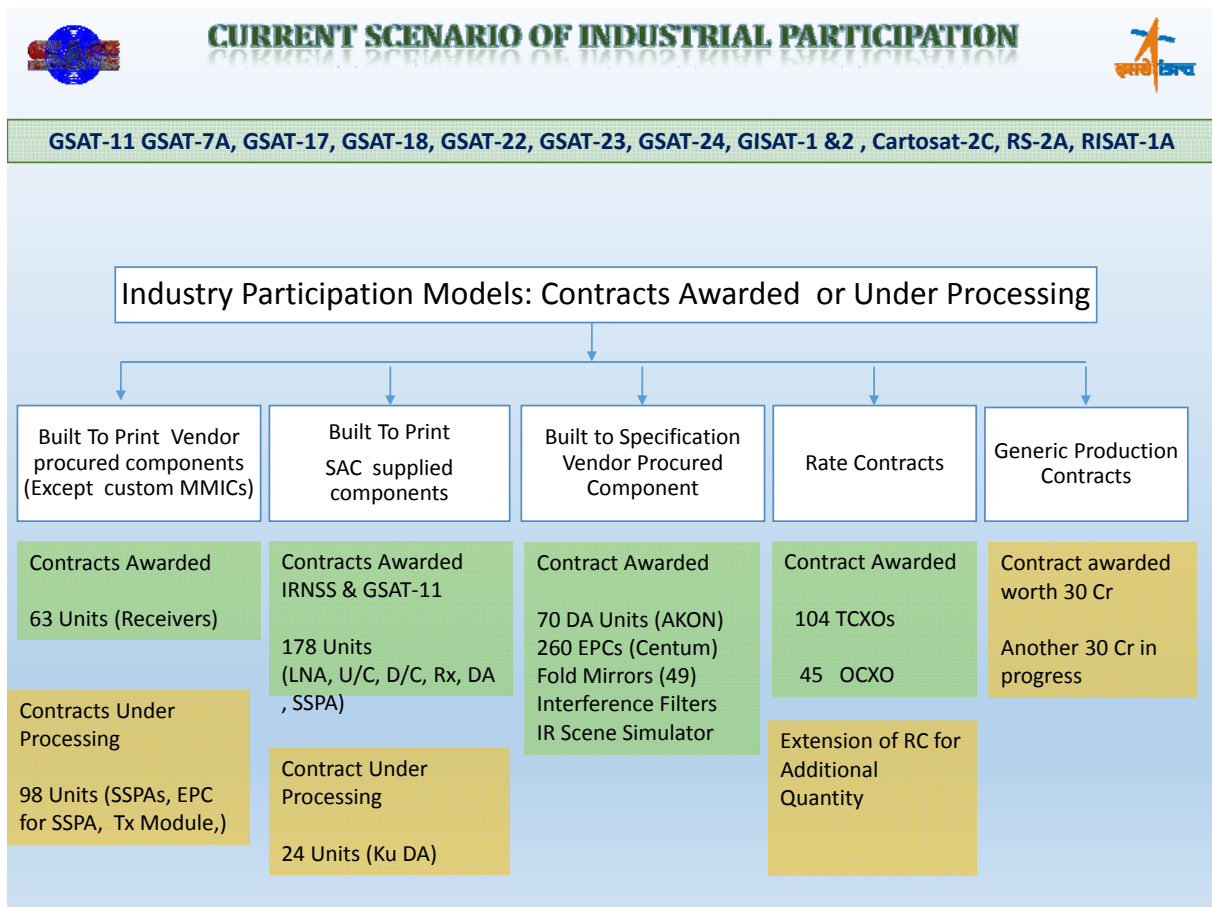
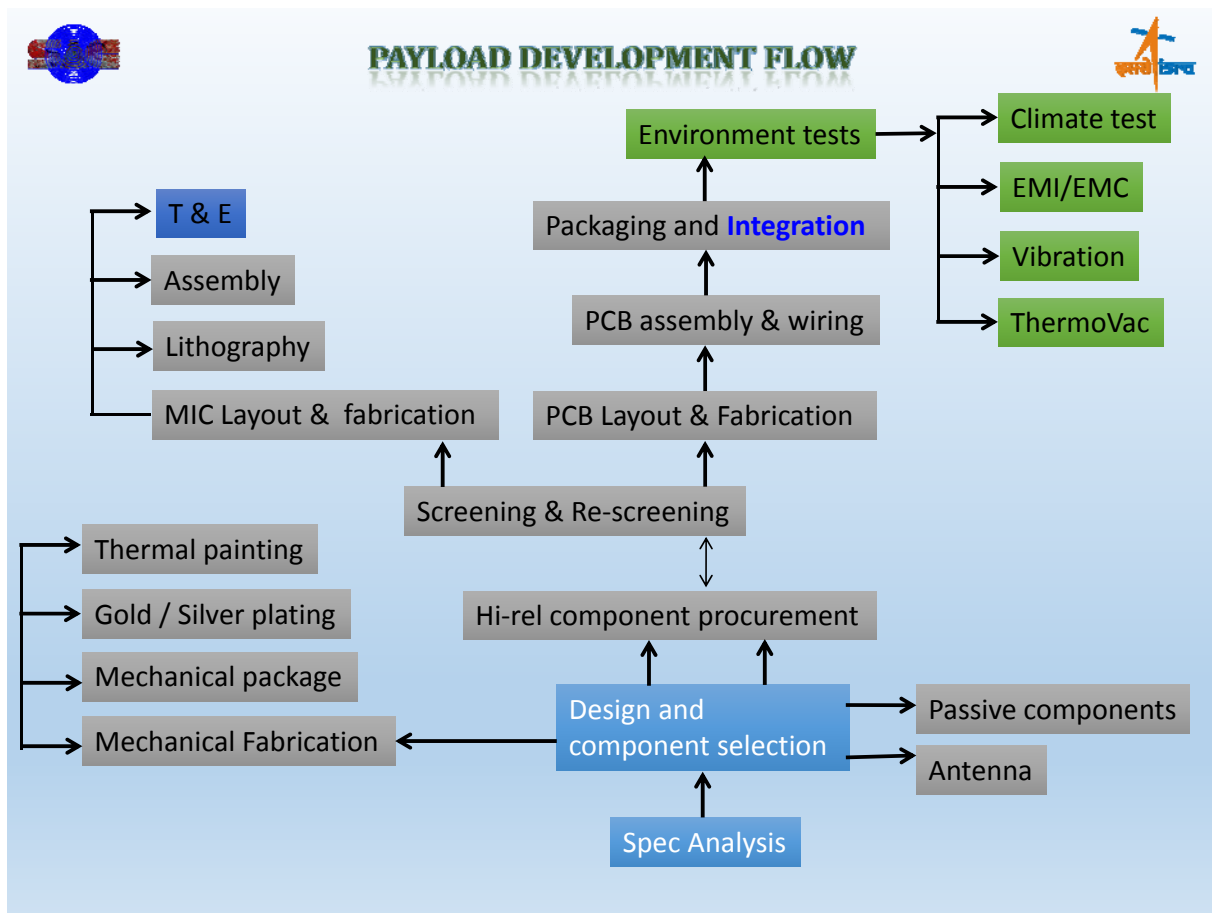
Harmonic Reject filter



Harmonic Reject filter

ELECTRO-OPTICAL PAYLOADS BLOCKS







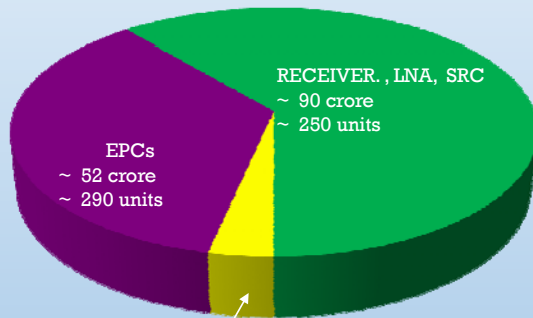
INDIAN INDUSTRIES PARTICIPATION



- Communication & Navigation Payload Flight Hardware's fabricated / under fabrication by Indian Industries

SUB-SYSTEMS

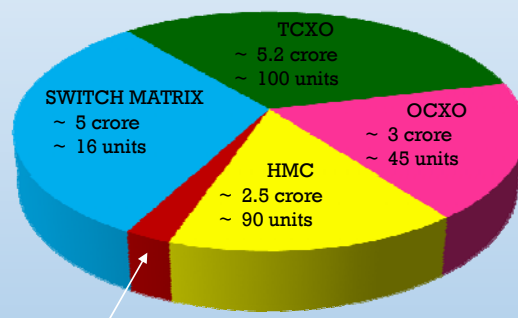
~ 600 UNITS
~ 150 CRORE



SSPA & Driver Amplifier
~ 5 crore
~ 45 units

COMPONENTS

~ 16 CRORE



CRYSTALS
~ 0.5 crore
~ 78 units

Due to upcoming High throughput satellites and Ka band satellite the hardware requirement will be increase manifold

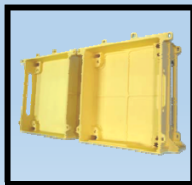


SURFACE TREATMENT PROCESSES DONE BY INDUSTRY



SURFACE TREATMENT JOBS DONE BY INDUSTRY

Sr.	Year	No. of Jobs	Surface Area (Lakh sq. cm)	Cost INR (Lakhs)
1	2009	2238	1.76	17.4
2	2010	405	1.45	18.9
3	2011	380	2.52	34.7
4	2012	920	2.27	27.4
5	2013	1248	2.45	32.3
6	2014	569	0.98	16.8
7	2015	2623	3.27	57.1
8	2016	5922	1.57	21.6
Total		14305	16.27	226.2



Gold Plating



Silver Plating



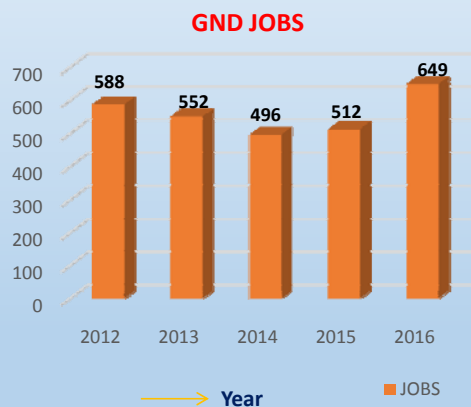
Black Anodizing & Silver Plating



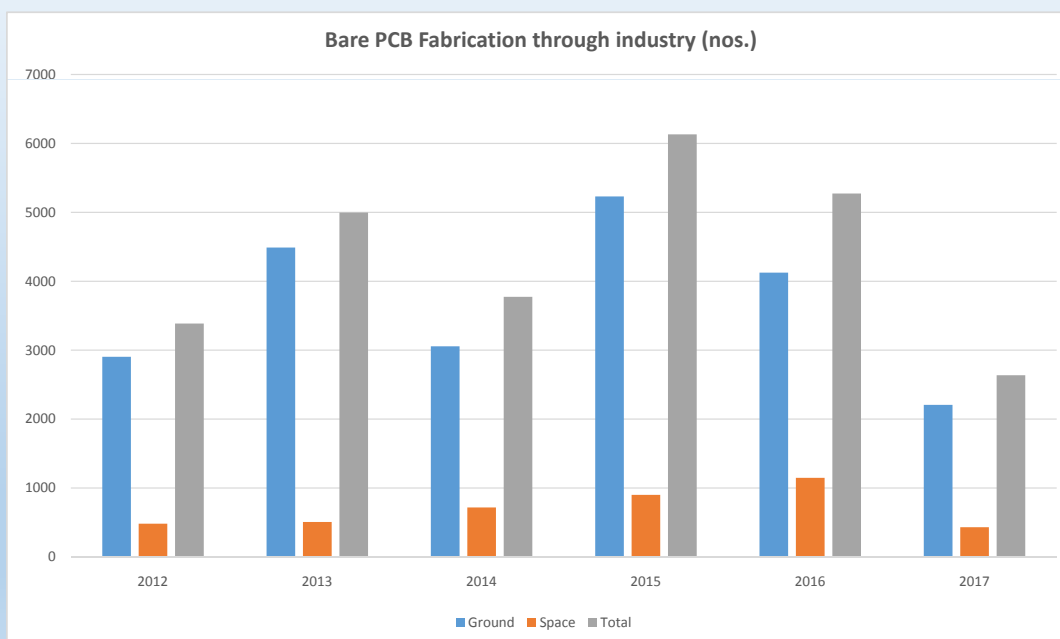
FM ELECTRONICS PCBS WIRING JOBS

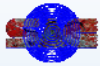


GROUND ELECTRONICS PCBS WIRING JOBS

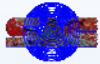
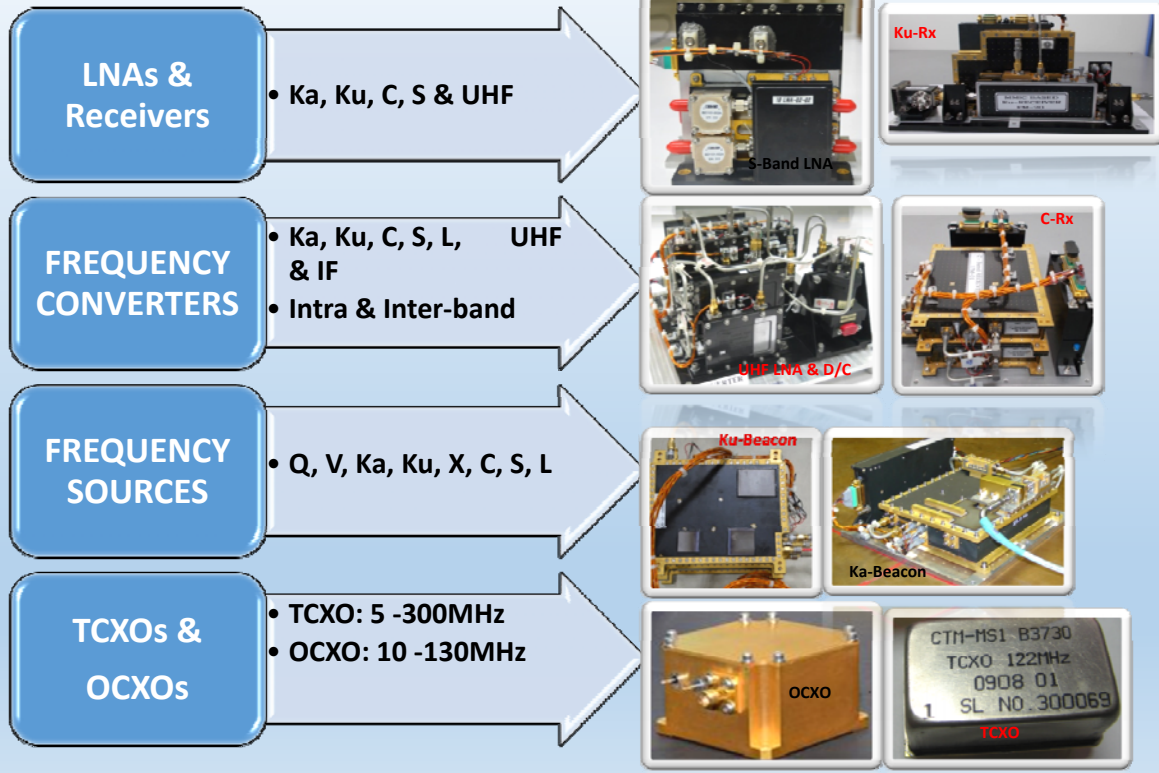


PCB FABRICATION (GLASS EPOXY) THROUGH INDUSTRY (2012 TO APR 2017)

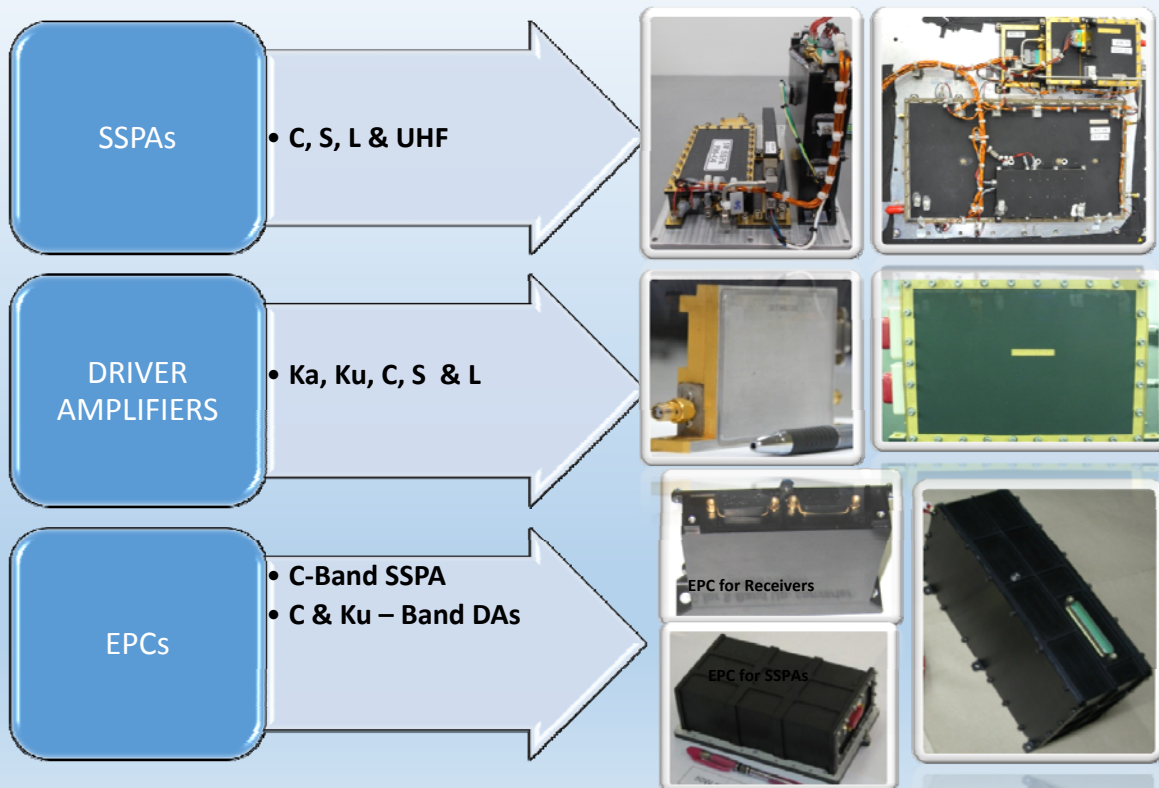


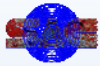


COMMUNICATION PAYLOAD SUB-SYSTEMS "MADE IN INDIA"

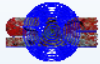
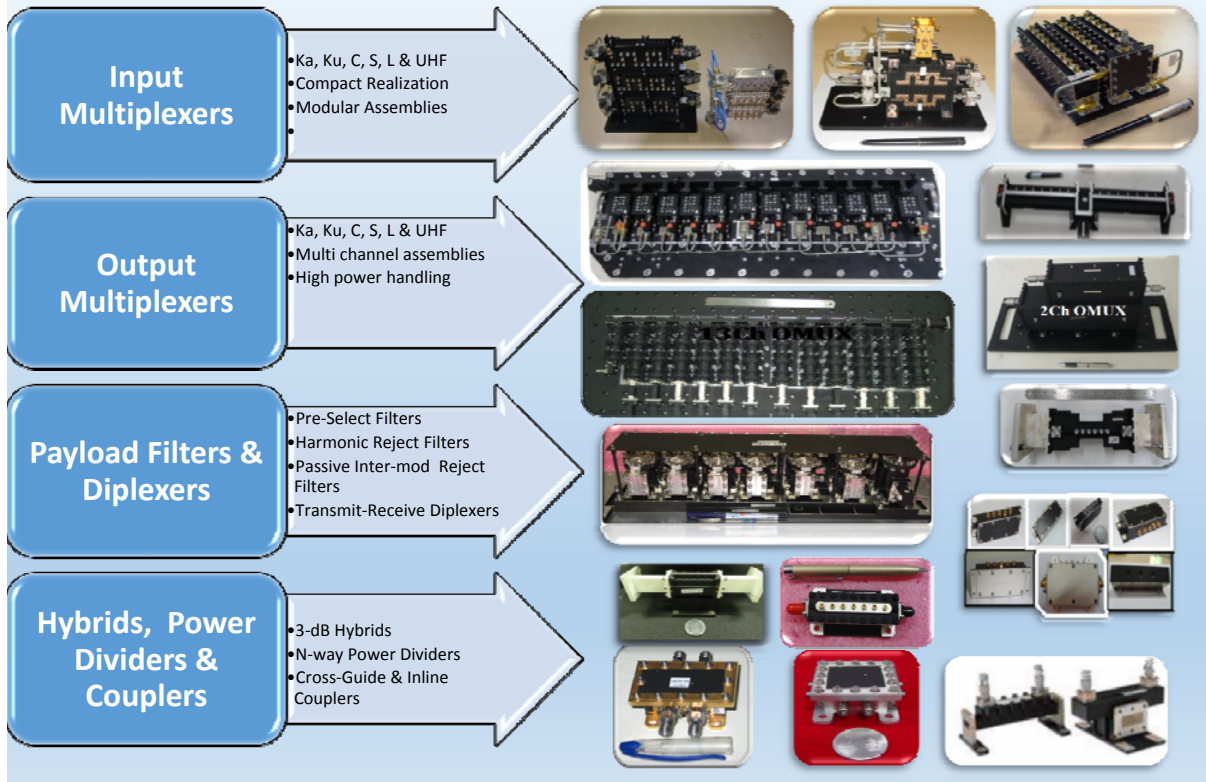


COMMUNICATION PAYLOAD SUB-SYSTEMS "MADE IN INDIA"

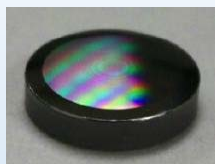




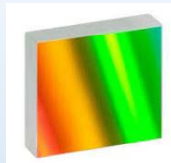
COMMUNICATION PAYLOAD SUB-SYSTEMS "MADE IN INDIA"



OPTICS AND FILTERS – TECHNOLOGIES



Diffraction Gratings, Plane and Convex
AMOS. BarndyWine Photonics



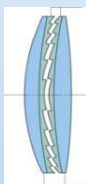
Mirrors and Optical Flats
SORL



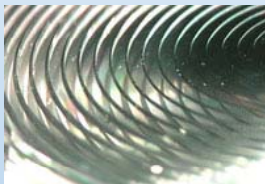
Linear Variable Filters
Barr Associates



Strip Filters
Materion, JDSU



Diffractive Optical Lenses



Visible and IR Spectrometers,
AMOS and Brandywine Photonics



Fabry-Perot Etalons
Light Machinery



SWIR Filters, Brinell Vision

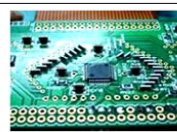


LWIR Filters, University of Reading

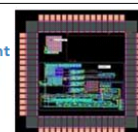
Miniaturized
discrete
power supply



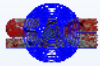
Vertical
mounting of
passive
components



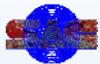
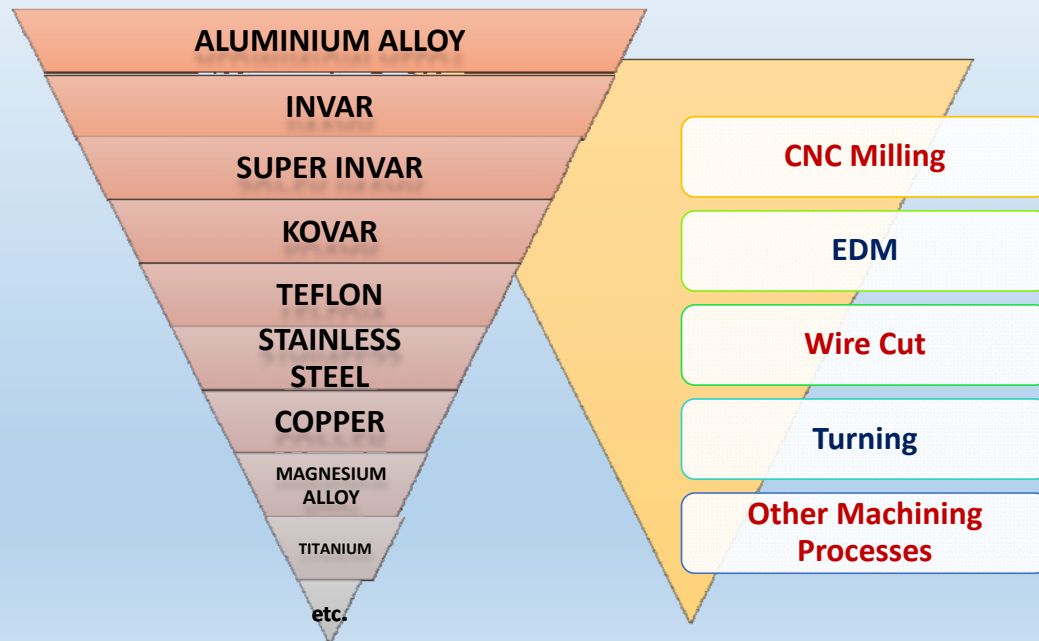
ASIC
Development
Tools & test
bench



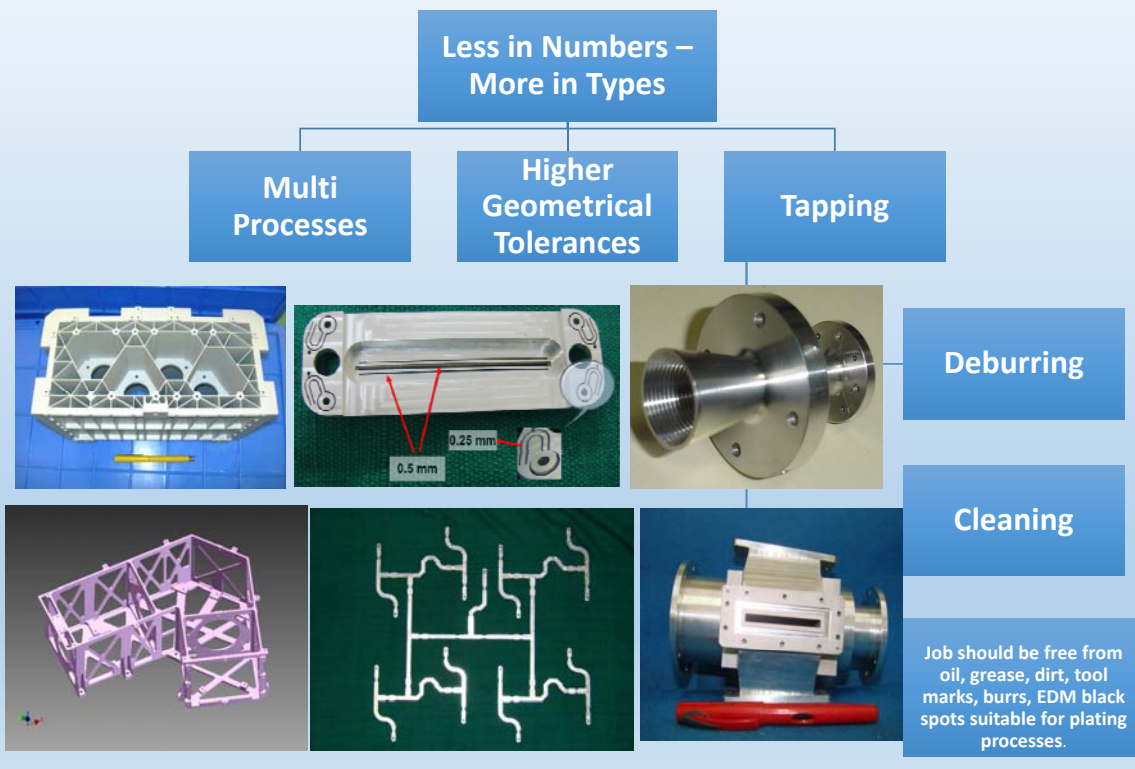
Miniaturized low power Electronics



MACHINING PROCESSES & MATERIALS USED

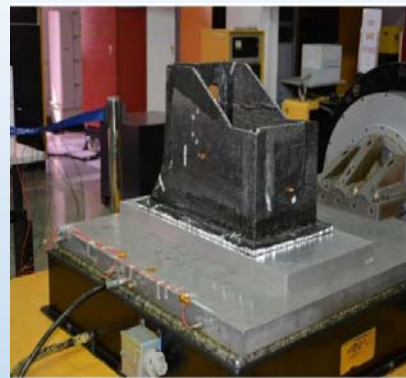


FABRICATION OF PAYLOAD MECHANICAL HARDWARE



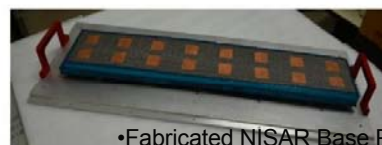
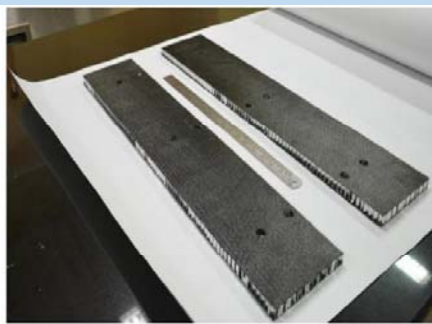


ANTENNA FEED COMPONENTS



Vibration testing of GSAT-11

Composite Feed bracket

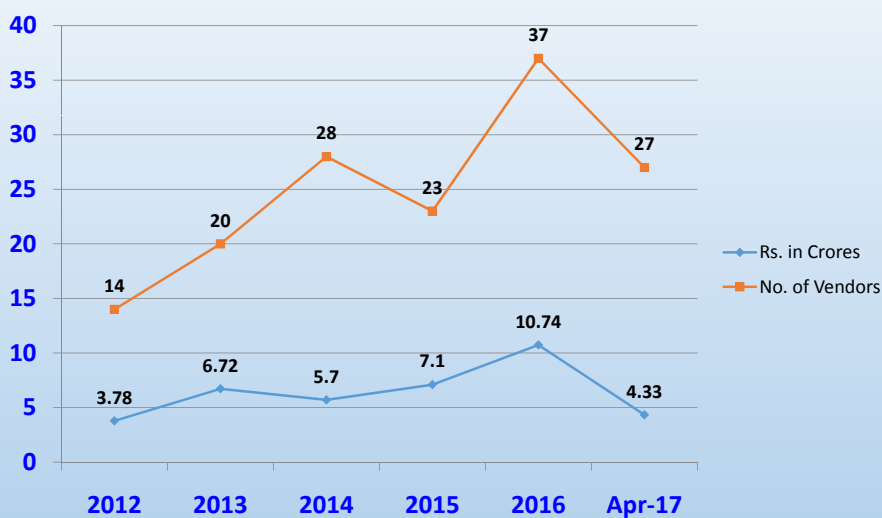


Fabricated NISAR Base Plate

Mass of Composite feed bracket: 0.8 Kgs Mass of Aluminum Feed bracket: 6.2 kg



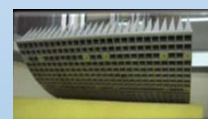
MECHANICAL HARDWARE MACHINING BY INDUSTRY 2012 TO APRIL 2017



Mounting Plate -
INSAT 3D Sounder



TIS STRUCTURE



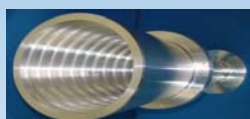
Black Body Target - TSU



Base Plate - INSAT 3D Sounder



TWIST



Horn



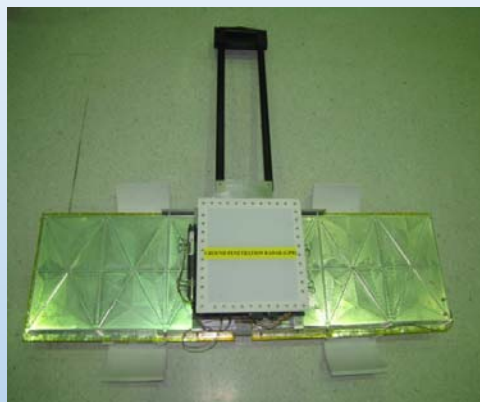
Mirror Fixing Device - Carto 2B



LISS III Structure-RS 2R



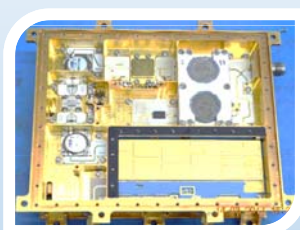
Ground Penetration Radar



A low cost, ultra-wideband GPR had been developed by SAC to map subsurface. It is operationally being used for snow/ice mapping by SAC scientists at Indian Scientific Expedition to Antarctica (ISEA).

Transmit Receive Module

Transmit Receive Module are the basic building blocks of an active phased array antenna providing transmit signal, high power amplification and receive signal low noise amplification with digitally controllable amplitude and phase in both transmit and receive paths.



This indigenously developed TRiM comprises of LTCC Module having Transmit, Receive and Calibration capability.

S-BAND



C-Band Dual Polarized Transmit Receive Integrated Module with two TR Module with TR controller in single Package.

C-BAND



X-Band LTCC Transmit Receive Module

X-BAND

Solid State Recorder

Salient Features:

Single ASIC can control T/R Modules
On chip 8 bit micro-controller with 32 bit floating point co-processor
Mixed Signal ASIC with on chip RS-422/485, ADC In-house design by SAC & SCL with Radiation Hardened by Design (RHBD) library and fabrication at SCL 180 nm CMOS process



OBC-2.2 (RHBD) ASIC

Indigenous On Board Controller (OBC) ASIC



Applications

- ❖ Airborne Missions
- ❖ Launch Vehicles
- ❖ Ground Checkout Applications.

Point of Load (POL) Converter

An efficient secondary post regulator to derive externally adjustable Voltage output (0.8V to 3.4V) with up-to 5A current from 4-6V input supply, suitable for high end FPGA requiring multiple low voltage, high current supplies. Multiple POIs can be configured for sequencing the power supplies for FPGA.

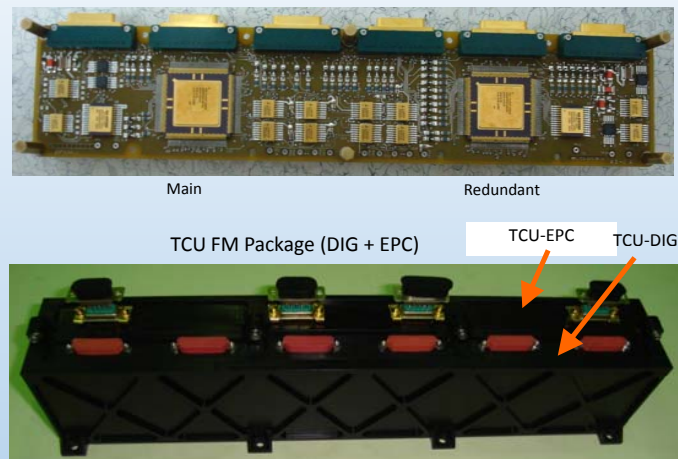
Key Features

- ❖ 500kHz Switching Frequency
- ❖ Up-to 92% efficiency
- ❖ <100uSec Transient recovery time
- ❖ <50mVpp Noise and Ripple
- ❖ Weight: 20Grams
- ❖ Size: 28.5mm X 28.5mm X 8mm



Hybridized POL Converter

Tile Control Unit (TCU)



Features:

- ❑ Input Interface with PLC-Main & Rednt, Output Interface to 24 TRCs & PCPU
- ❑ Main & Rednt section on same PCB
- ❑ OBC-1 ASIC
- ❑ 24 PCPU On/Off signal generation
- ❑ Timing Signal buffering

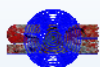
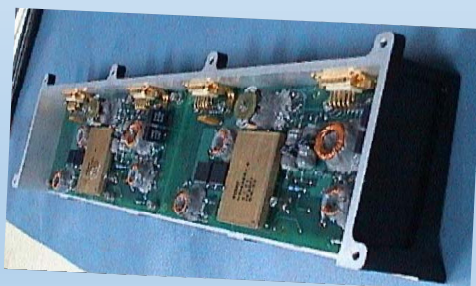
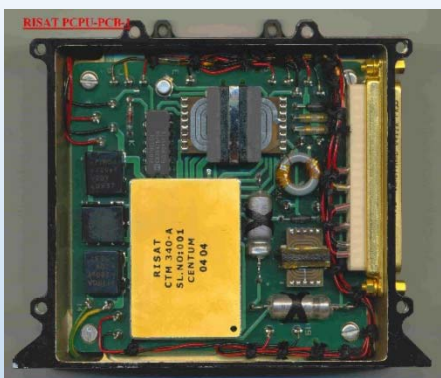
T/R Control (TRC)



Features:

- ❑ Integrated package for Digital and RF(TRiM)
- ❑ Single Controller for H & V Pol. RF Circuit
- ❑ In-Circuit Programming capability using EEPROM
- ❑ RF biasing circuits co-housed in single PCB
- ❑ High Current Pulsed Supply and DC Supply routing in digital PCB
- ❑ Single Connector Interface to TCU & PCPU

Electronic Power Conditioners



FUTURE SCENARIO: PRODUCTION THROUGH RATE CONTRACT



2017-2021 : GEOSAT & IRNSS Generic Sub-Systems/Modules

Rate Contract Models & Sub-Systems

Rate Contract
With
Technology Transfer
(ISRO Licensee)

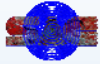
Rate Contract
Built to Print

Rate Contract
Built to Specification

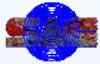
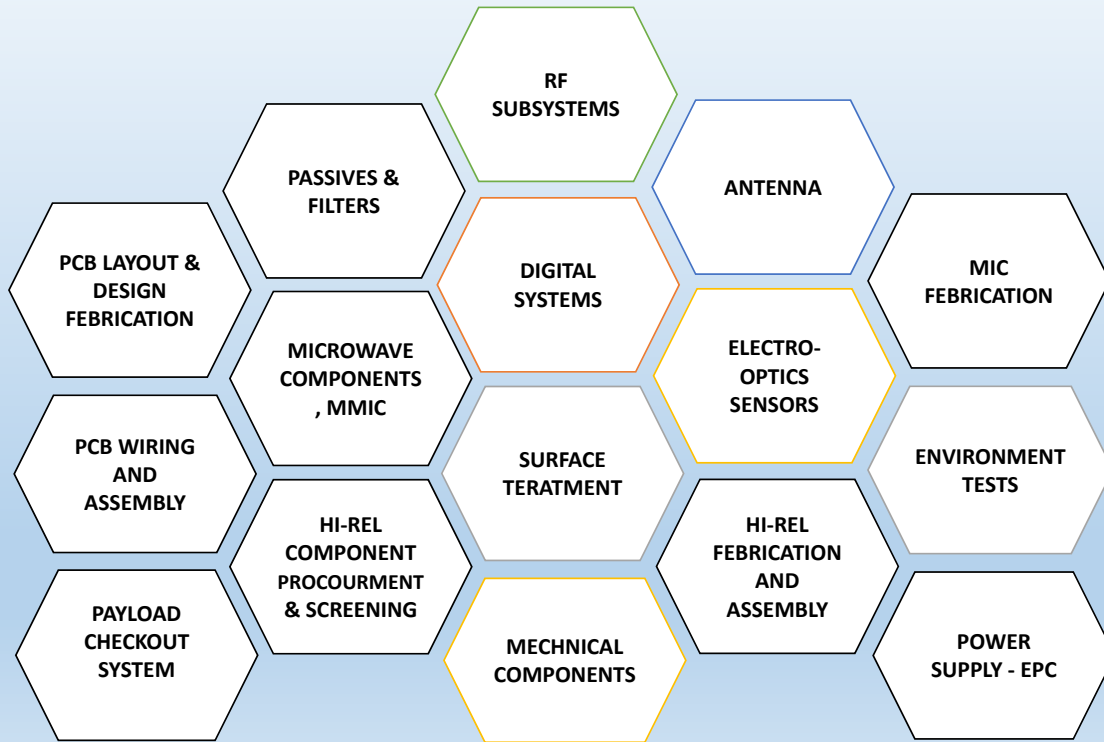
C-Nor SSPA : 36
C-Ext SSPA : 18

Receivers : 12
Down Converter : 6
C-Band DA : 20
Ku Band DA : 36
Beacon Tx : 10
I-Mux & Passives : 100+

TCXO/OCXO: 100+
EPCs : 100+



PAYLOAD SYSTEMS – POTENTIAL AREAS



AREAS OF PARTNERSHIP



Component Level

- MMIC
- ASICs
- HMC
- Lenses
- Mirrors
- Band Pass Filters
- Crystal Oscillators
- Waveguides
- PCB-MLB Fabrication
- Cables
- Mechanical Components

Subsystem Level

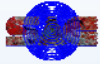
- SSPA
- EPCs
- Transmit Receive Module
- Calibration Switch Matrix
- Payload Controller
- Driver Amplifiers
- Filters
- Down Converter
- IMUX/OMUX
- Data Acquisition and Compression Subsystem (DACS) and Digital Chirp Generator (DCG)
- Forging the structures

System Level

- Assembly & Integration
- Test Fixtures
- Integration Fixtures
- TRM
- Automated Test System
- Ground Checkout Unit

Facilities

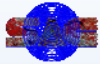
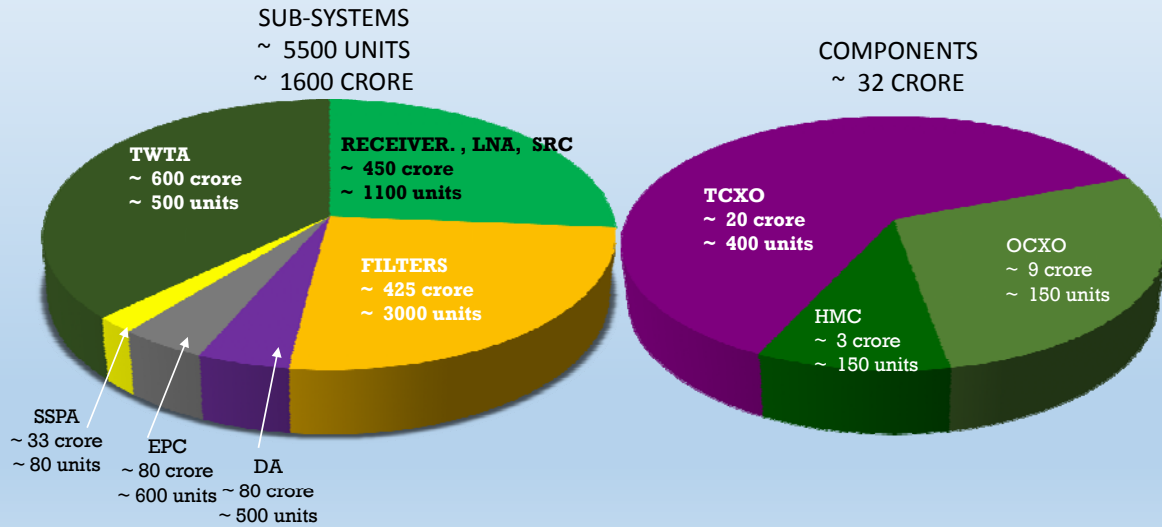
- T & M instruments
- Thermovac Chambers
- Climatic chambers
- Chemical painting
- Mechanical testing facilities
- 3 Axis Scanner



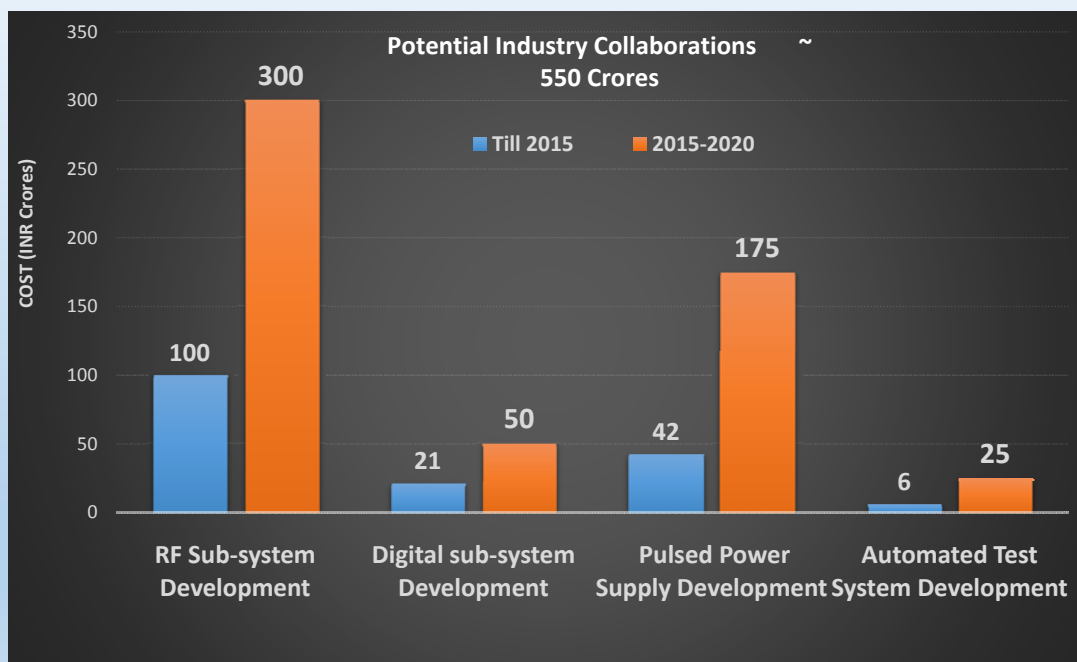
OPPORTUNITIES AHEAD

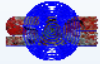


(REQUIREMENTS DURING 2016-2021)

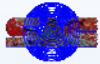
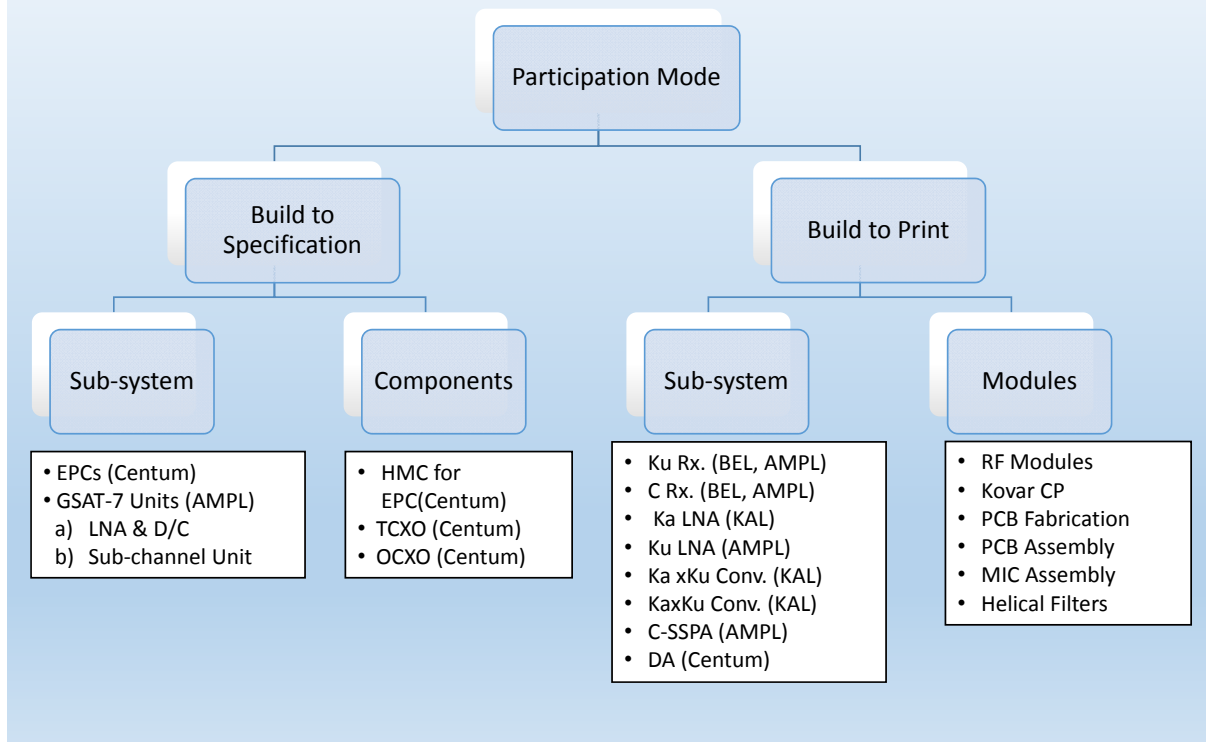


OPPORTUNITIES AHEAD





INDUSTRY PARTICIPATION MODEL



OUTSOURCING REQUIREMENT & SUPPORT (ORS) TRIANGLE



Quality Certification – Zero Defect	Capacity Building	Technology Transfer	Technical consultancy	Test facility support
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INDUSTRY INTERFACE - SAC INDUSTRY PORTAL



COVERAGE

The portal is broadly categorized & provides good amount of technical information in the following categories:

- Technology Offers
- Industry Interface
- Business with SAC
- Indian Space Programmes
- E-procurement
- Reliability and Quality Assurance

Web pages are provided for the following topics:

- Technology Transfer Offers
- Indigenisation
- Intellectual Property Rights
- Technical Consultancy
- Hi-Rel electronics training
- SAC Testing facilities
- Technology Promotion
- Electronics and Mechanical support facilities
- Publications
- E-Procurement
- Reliability & Quality Assurance



<http://www.sac.gov.in/SACSITE/TTIDWebsite/index.html>

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Thank you

Vivek Pandey
Technology Transfer & Industry Interface
Division(TTID),
PPG, SAC/ISRO , Ahmedabad

Email: vivekpandey@sac.isro.gov.in
Web: www.sac.gov.in



Outsourcing of Inertial Systems Production

D Sam Dayala Dev
Director, IISU

ISRO Inertial Systems Unit
Thiruvananthapuram



ISRO Inertial Systems Unit



ISRO Inertial Systems Unit (IISU) was established in July 1990 as an independent Unit of ISRO with a mandate to carry out research and development activities towards inertial sensors, systems and mechanisms for various ISRO missions



The Unit is located at Vattiyoorkavu in Trivandrum and a separate facility called Sintered Materials Machining Facility (SMMF) is located at BARC Navi Mumbai.

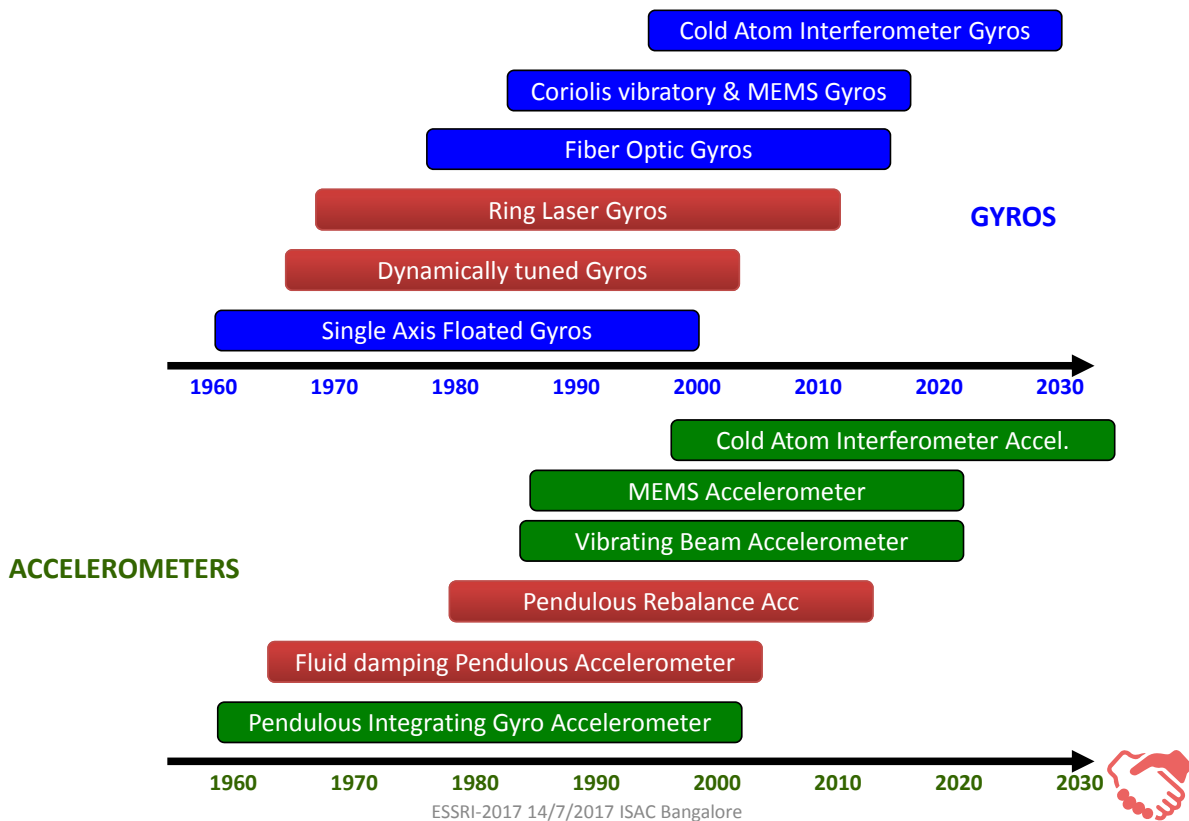


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EVOLUTION OF SENSOR TECHNOLOGY





Inertial Systems for Launch Vehicle



Sensors

- DTG/miniDTG
- ISRO Laser Gyro
- Servo Accelerometers
- Ceramic Servo Accelerometers

Systems

- Redundant Strapdown Inertial Navigation System (RESINS)
- Advanced Inertial Navigation System based on Laser Gyro(AINS)
- Rate Gyro Package (RGP)
- NAVIC Aided INS (NAINS)

Software

- Navigation Software



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Inertial Systems and Mechanisms for Spacecraft



SENSORS

- .. DTG/miniDTG
- ... ISRO Laser Gyro

SYSTEMS

- Inertial Reference Unit (IRU)
- Inertial Reference & Acceleration
- Measurement Package (IRAP)
- Laser Gyro Based Inertial Referencing and Accelerometer Package (LIRAP)
- Momentum Wheel Assembly (MWA)
- Reaction Wheel Assembly (RWA)
- Solar Array Drive Assembly (SADA)
- Scan Mechanism for VHRR
- Payload Mechanism for IRS



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1. Inertial Reference Unit (IRU)

- Used for 3 axis stabilisation of spacecraft.
- Fully Redundant System.
- Uses 3 Nos. of DTGs with electronics.
- Flown in IRS and INSAT / GSAT missions.



Configuration	No.of cards/Package	Man Days	Percentage Outsourced
IRU400(IRS)	6	150	75
IRU200(GEO)	7	60	80
IRU300(mini)	3	90	NIL

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2. Reaction Wheel Assembly

- Consists of two Units:
 - .. Reaction Wheel
 - High precision Ball Bearing Unit
 - Fly Wheel
 - Drive Motor
 - Housing
 - .. Wheel Drive Electronics



Configuration	No.of cards/Package	Man Days	Percentage Outsourced
WEE700(IRS)	8	180	75
WEE600 (IRS)	8	132	80
WEE900 (mini)	4	60	NIL

For Attitude Control of IRS Type spacecraft

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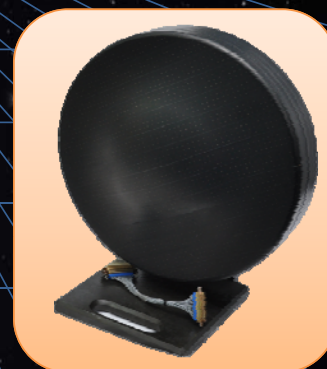
3. Momentum Wheel Assembly

- Used for stabilization of INSAT/ GSAT S/C
- Consists of:

- Momentum Wheel

- Bearing Unit
- Fly Wheel
- Drive Motor
- Housing

- Wheel Drive Electronics



Configuration	No.of cards/Package	Man Days	Percentage Outsourced
WDE700/800 (GEO)	9	69	80
WEE700A (3D)	8	188	75

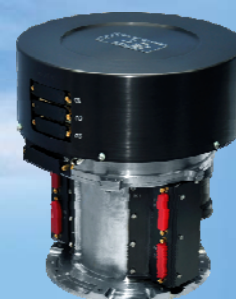
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4. Solar Array Drive Assembly (SADA)

- Used to Rotate Solar Panels to Constantly track the Sun.
- Two Different Versions - IRS & INSAT Types.
- Consists of:

- ... Stepper Motor Drive
- ... Solid Lubricant Bearings
- ... Drive Electronics



Configuration	No.of cards/Package	Man Days	Percentage Outsourced
SDE400(IRS)	4	88	85
SDE200(GEO)	18	144	85
SDE600(mini)	6	154	NIL

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5. Payload Mechanisms

- Scan Mechanism for VHRR (INSAT)
- Imager and Sounder Scan Mechanism

Scan Mirror Mechanism is a two axes gimbaled servo drive for VHRR. Used for meteorological applications and flown in various INSAT missions.



Configuration	No. of cards/Package	Man Days	Percentage Outsourced
SME500 (Img)	15	220	85
SME600 (snd)	17	252	85

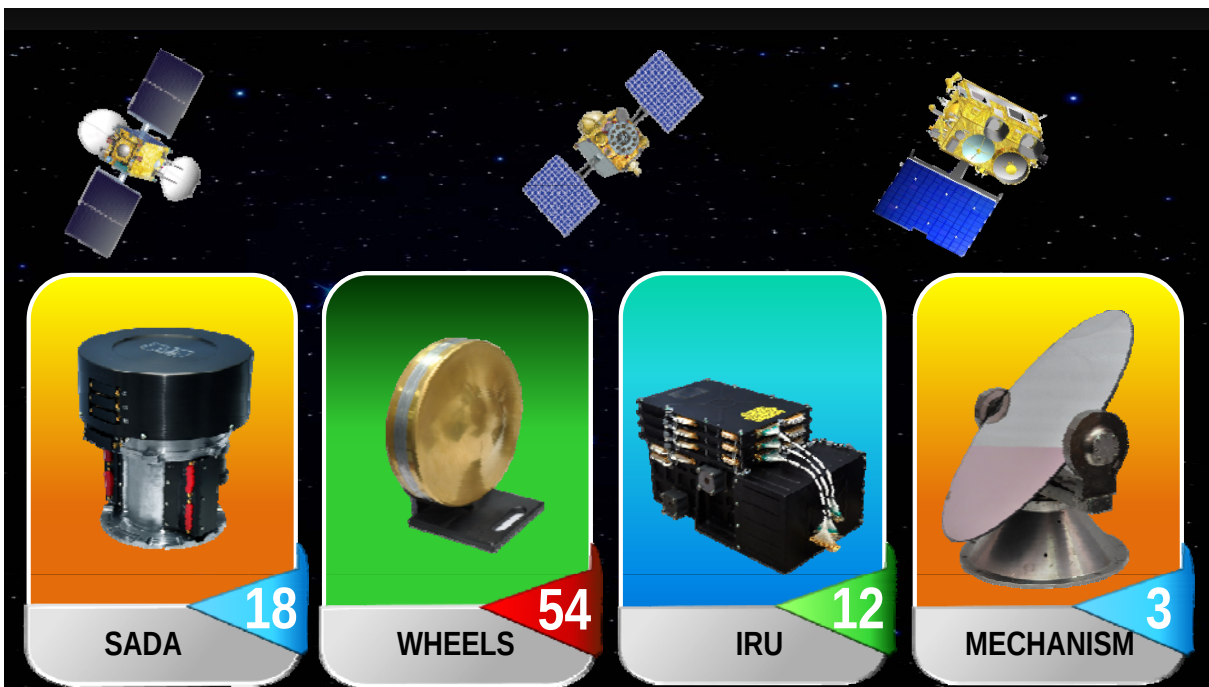
Consists of :

- Beryllium Mirror
- Torque Motor
- Angle Encoder
- Electronics

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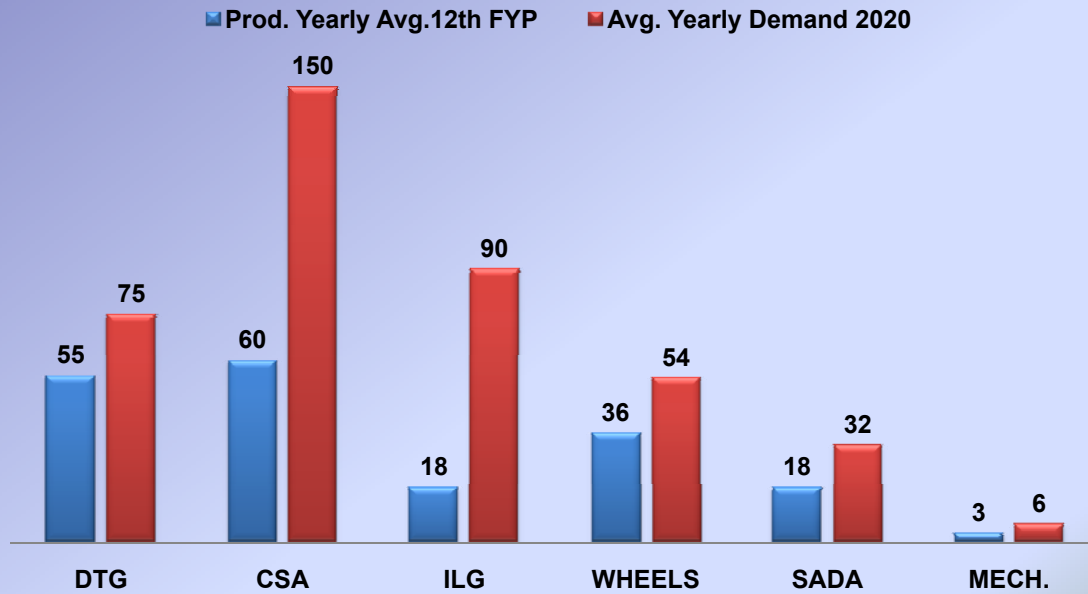


Yearly Spacecraft System Requirements



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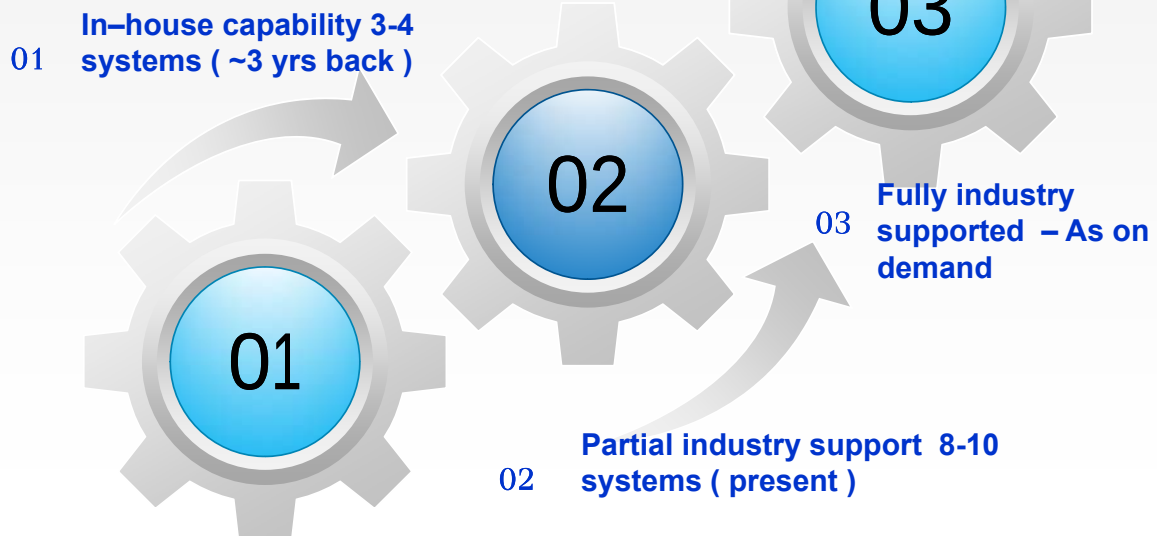




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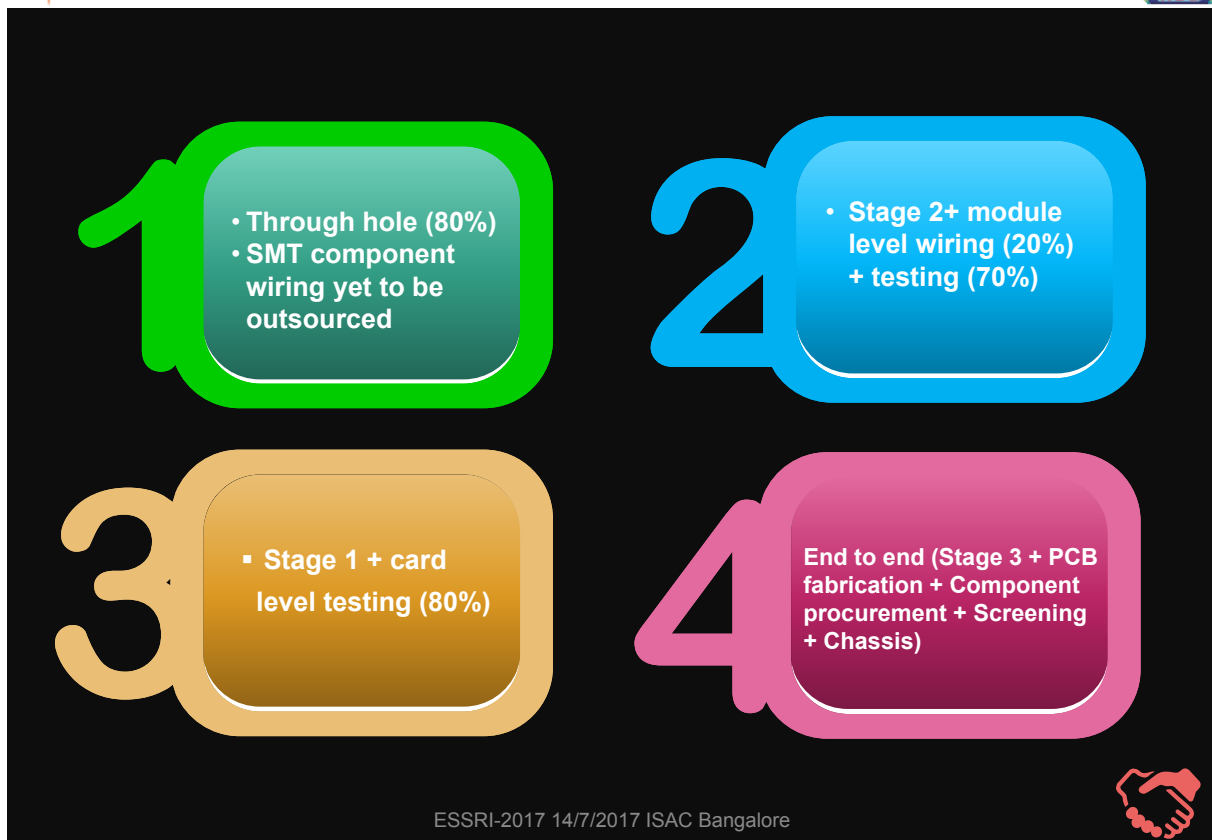


One System (IRU + 4 wheels + 1 or 2 SDA)

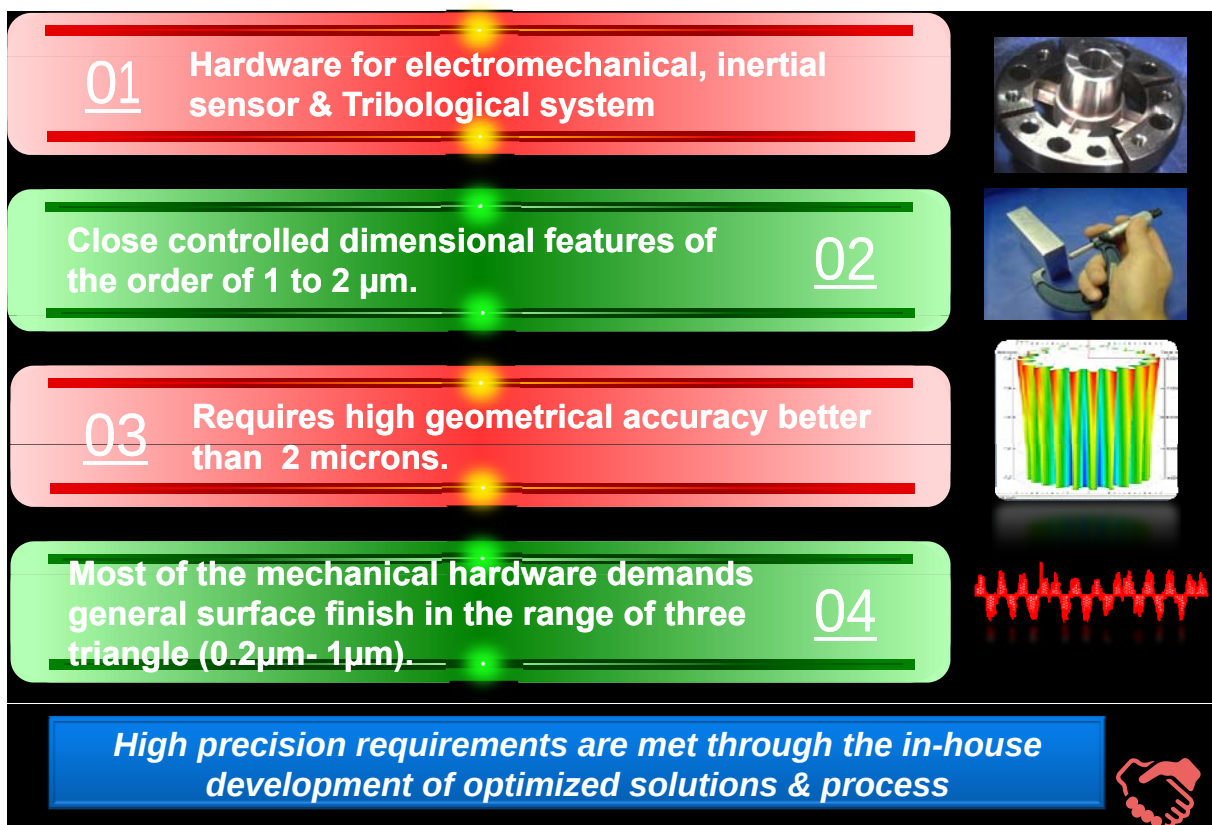


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Features of IISU Mech hardware

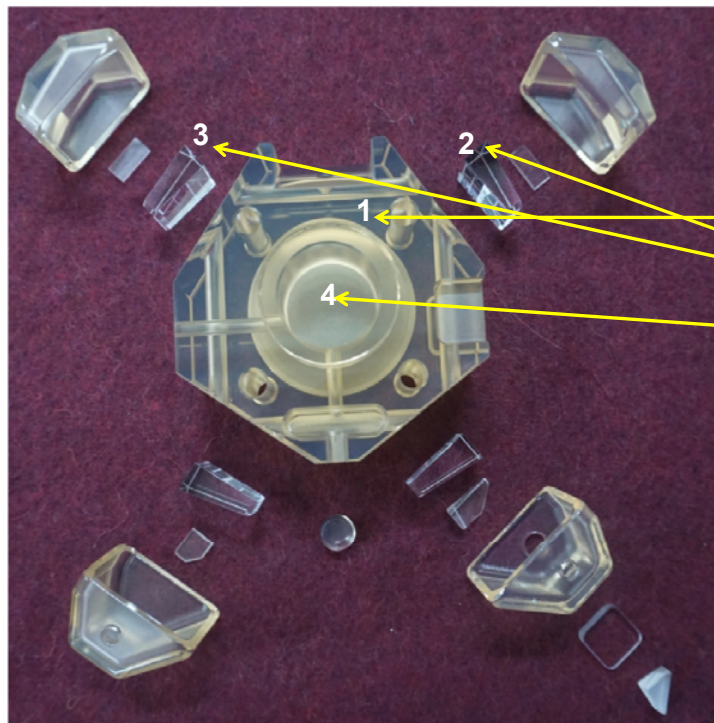


Precision Class	Industry	Type of Components
High Precision (Class-A) (Less than 3 μm)	CTTC, Bhubaneswar Brahmos aerospace	End to End to Production of Mech Components
Medium Precision (Class-B) (3 to 6 μm)	Microtech precision, Hyderabad Amado tools, Bangalore AIS, Nazareth LTE Coimbatore Craftsman Automation, Coimbatore Mech vacc, Mumbai MTAR, Hyderabad ECIL, Hyderabad	Semi Finished Hardware Components
Low Precision (Class-C) (6 to 12 μm)	Micro Tech Engineering, Bangalore K max industries, Chennai Jojo Industries, Ettumanor Microfine Bushings, Chennai	Rough Finished Hardware Components

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Optical Components Fabrication



- 1. Sensor Block
- 2. Total Reflection Prism flat
- 3. Total Reflection Prism – Spherical
- 4. Glass seals

Finished products
from Indian industry

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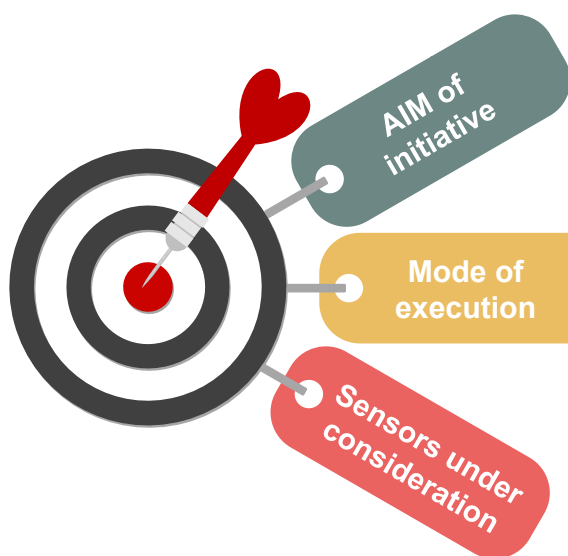
Outsourcing Scenarios

- o Sensor Licensed Production
- o End to End Electronic Packages
- o Sensor/System Integration & Testing



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Licensed Production of Inertial Sensors



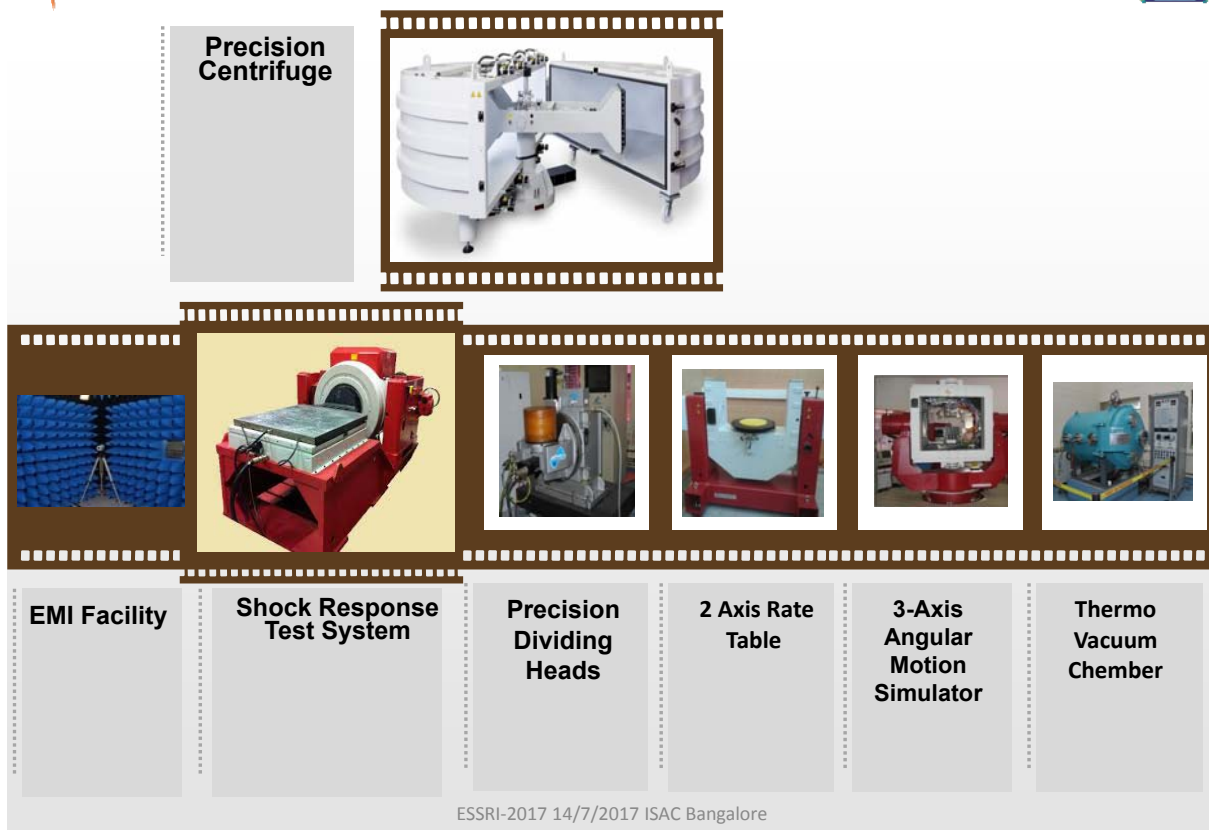
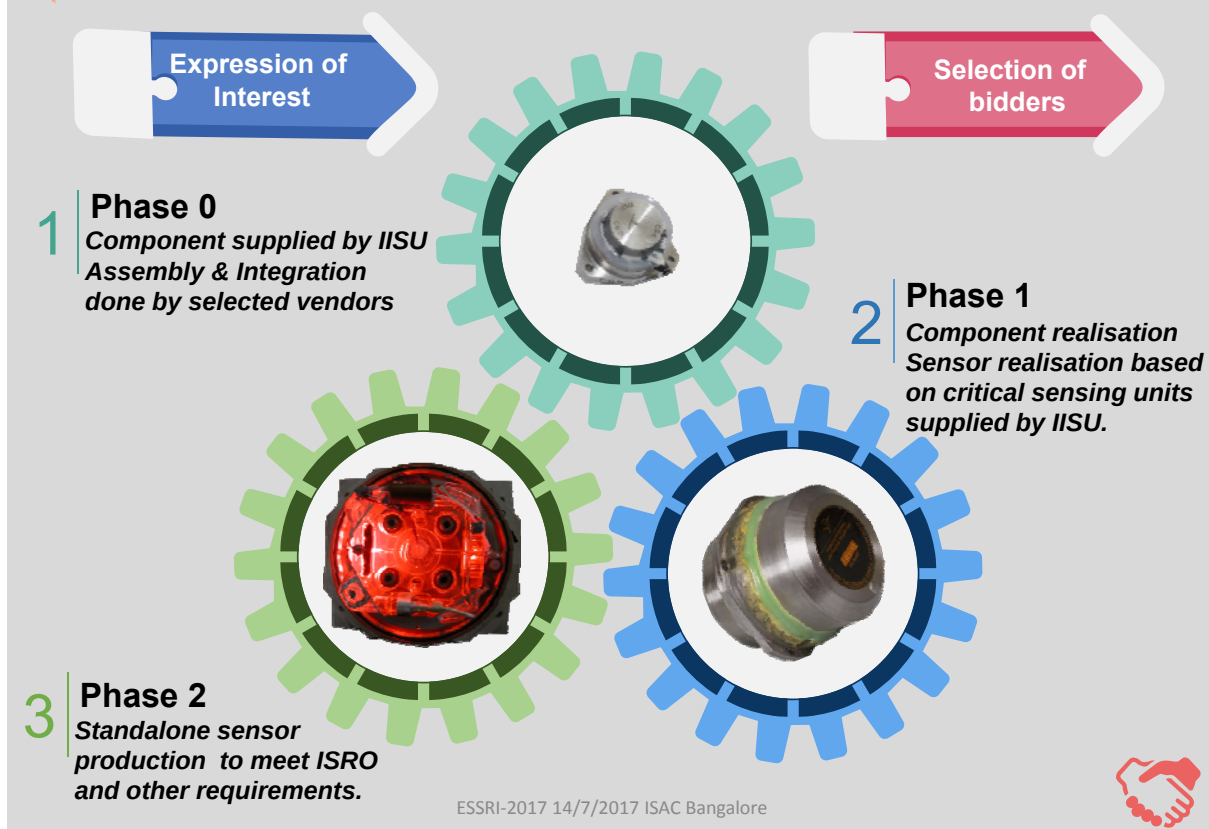
Nucleation of Inertial Sensors Industry in India

Non-exclusive development of Indian Industry to produce Inertial Sensors

- Dynamically Tuned Gyro (DTG)
- ISRO Laser Gyro (ILG)
- Ceramic Servo Accelerometer (CSA)

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Outsourcing Road map

System Realization and T&E by Industry

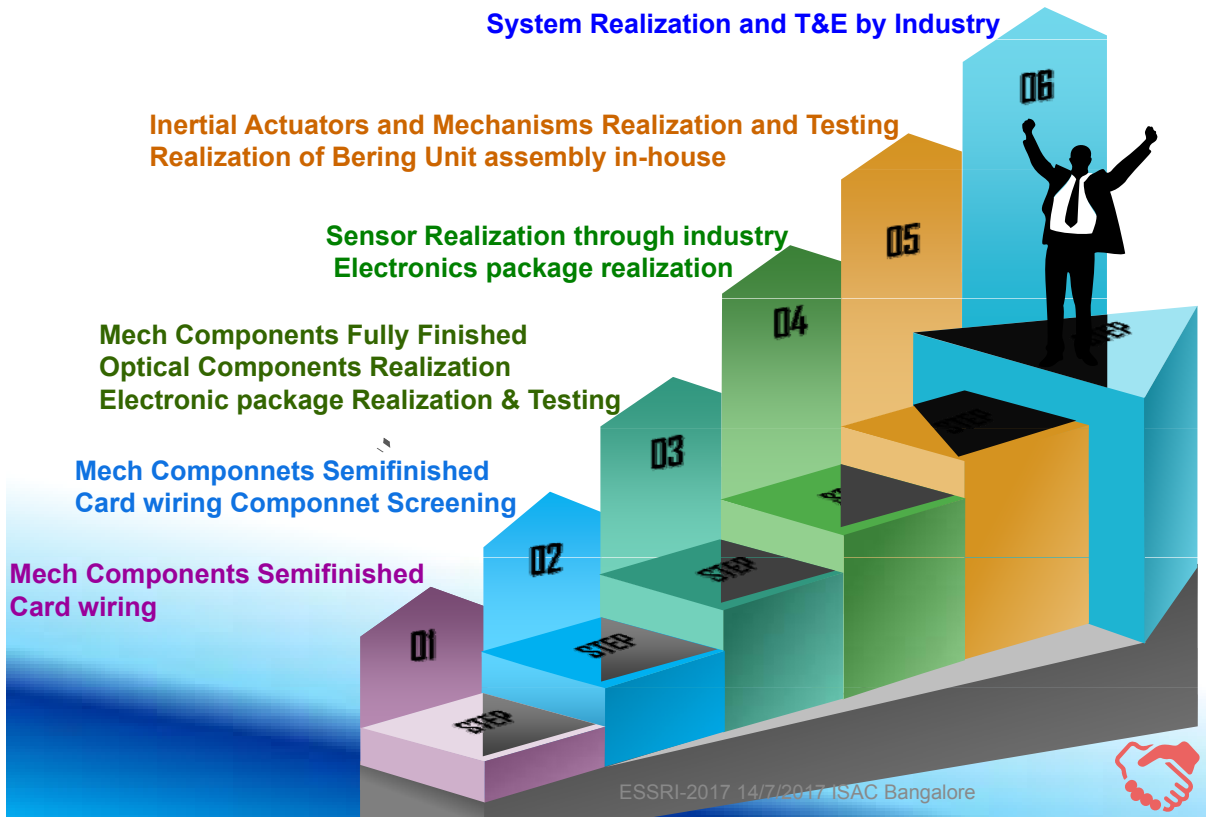
Inertial Actuators and Mechanisms Realization and Testing
Realization of Bering Unit assembly in-house

Sensor Realization through industry
Electronics package realization

Mech Components Fully Finished
Optical Components Realization
Electronic package Realization & Testing

Mech Componnets Semifinished
Card wiring Componnet Screening

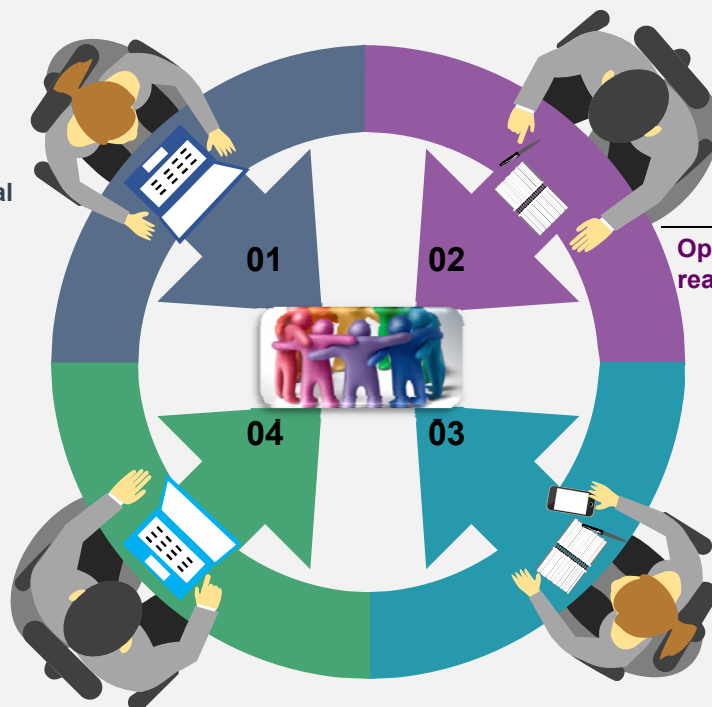
Mech Components Semifinished
Card wiring



Outsourcing Through Consortium

Finished Mechanical
Hardware

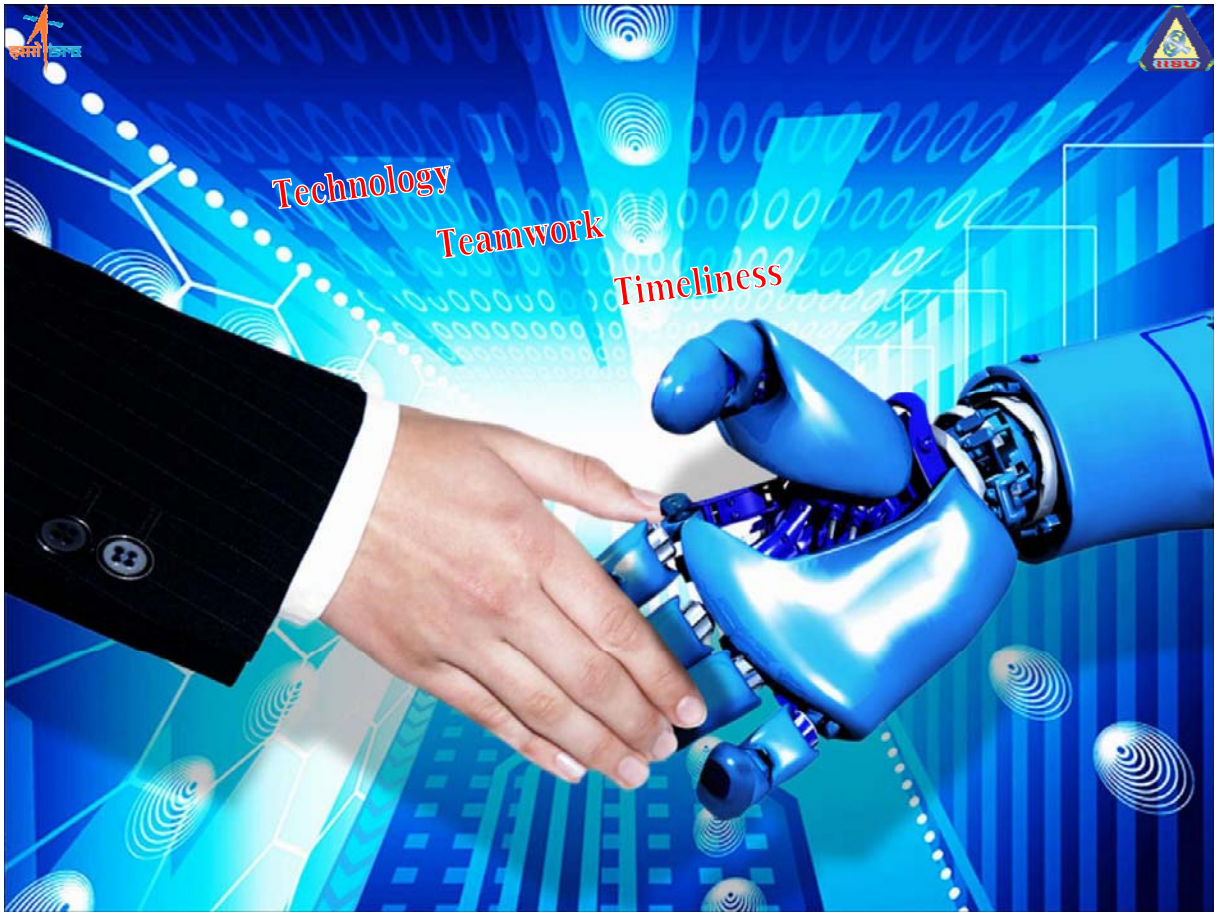
System Integration
& Testing



Optical Component
realization & Assembly

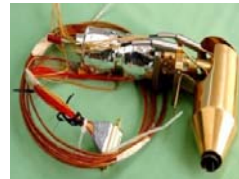
End-to-end Electron
Package Realization

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Outsourcing of Propulsion Elements

D. Gangadhar
Associate Director
LPSC, Bangalore

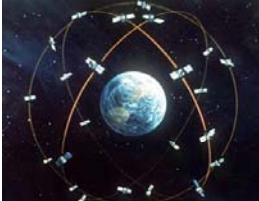
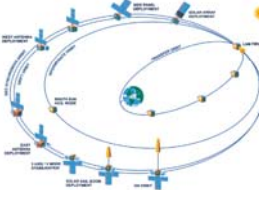
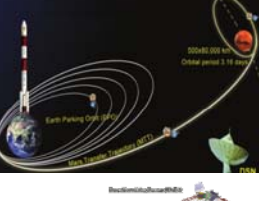
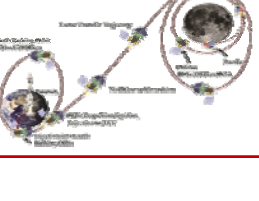
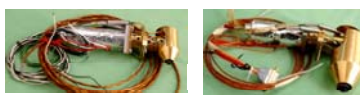
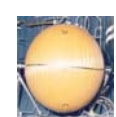


Enabling Spacecraft Systems Realisation through Industries (ESSRI)-2017
14th July 2017.

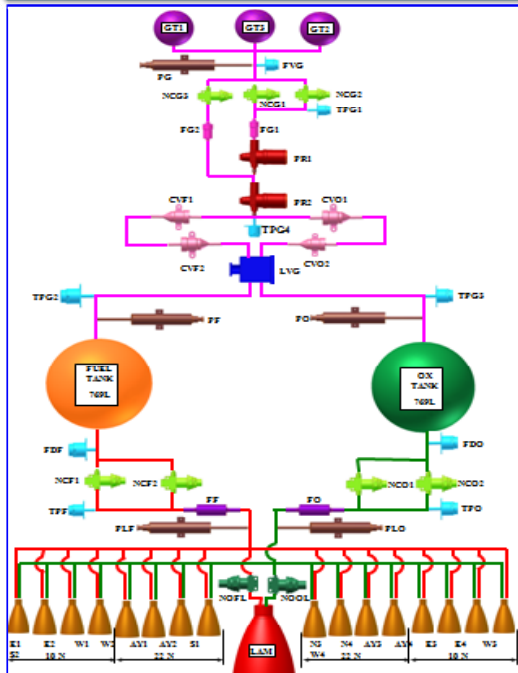


Propulsion System Elements



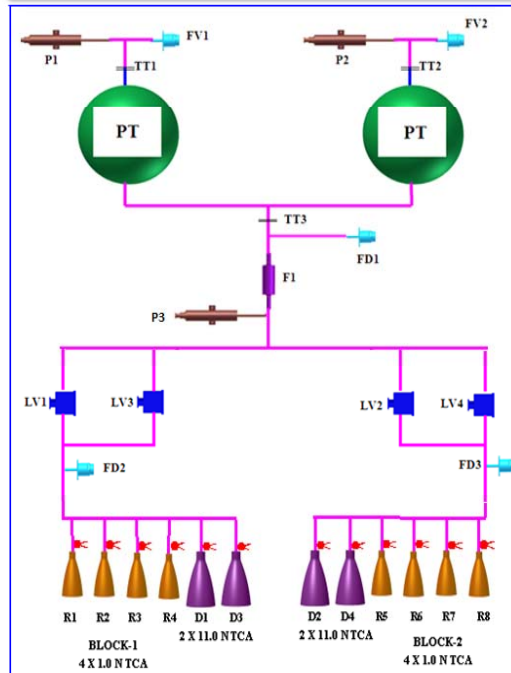
 LEO Missions  GEOSAT Missions  Interplanetary Missions  Moon Missions	Spacecraft Engines   	System components     Propellant / Pressurant Tanks     
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Bipropellant System



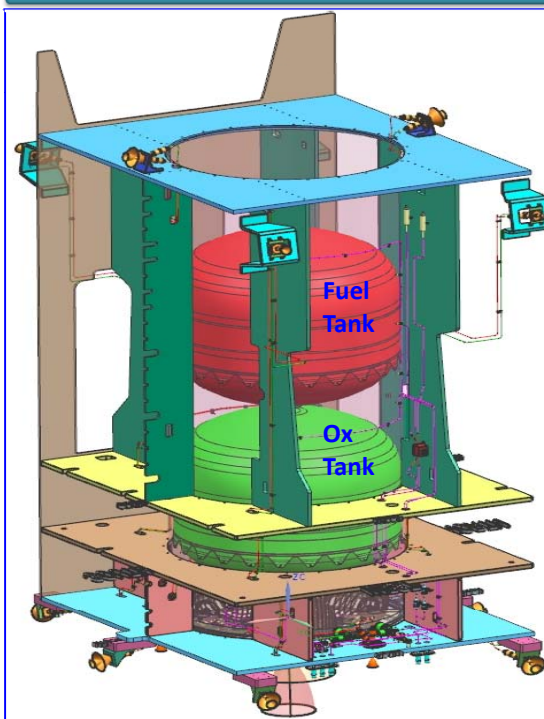
Total components: 90 nos. of 16 types

Monopropellant System

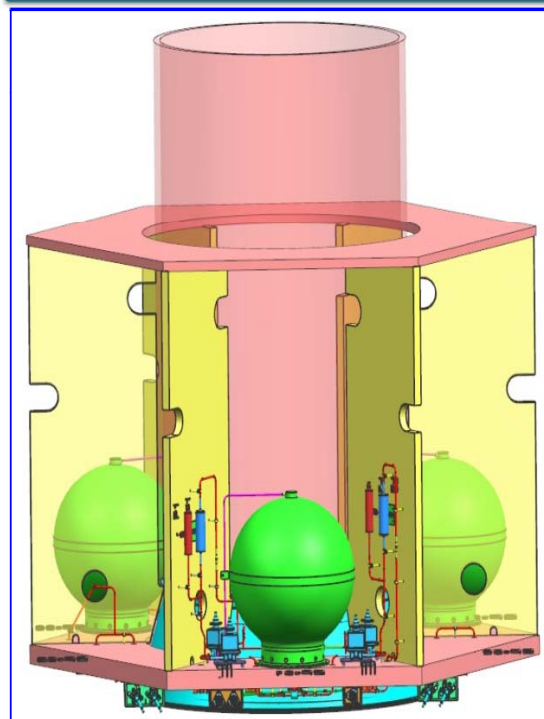


Total components: 40 nos. of 9 types

Bipropellant System



Monopropellant System



Monopropellant components



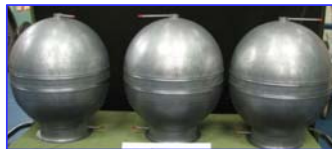
1N Thruster & FCV



30 L Propellant tank



Latch Valve



35 L Propellant tanks



11N Thruster & FCV



Filter

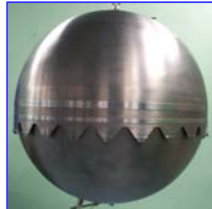


390 L Propellant tank

Bipropellant components



516 L Propellant tank



780 L Propellant tank



Filter Venturi



F&D Valve



Pressure Regulator



Latch Valve



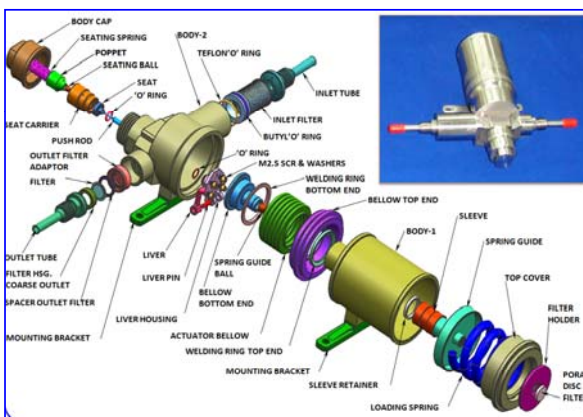
Check Valve



22N Thruster



LAM



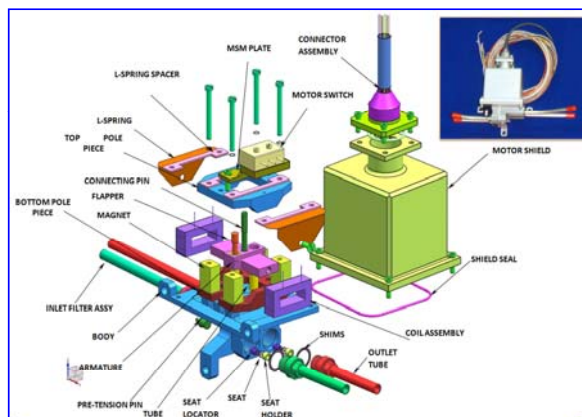
Pressure Regulator

Fabricated parts: 25 Nos.

Standard parts : 14 Nos.

EBW Joints: 13 Nos.

Mass: 1.0 kg.



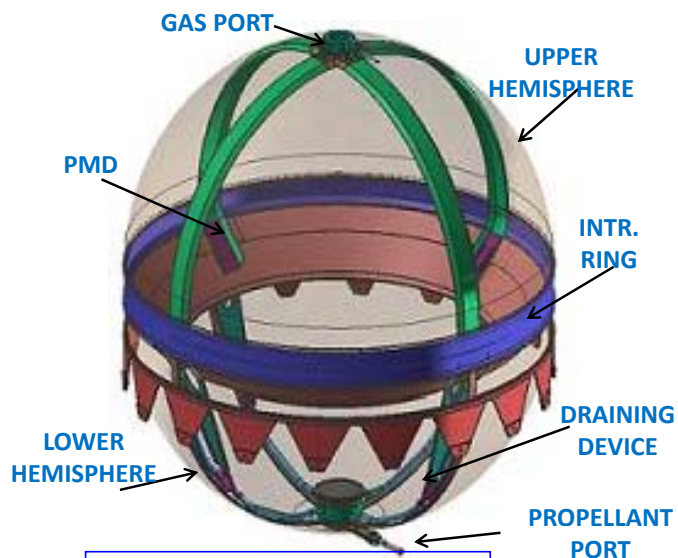
Latch Valve

Fabricated parts: 21 Nos.

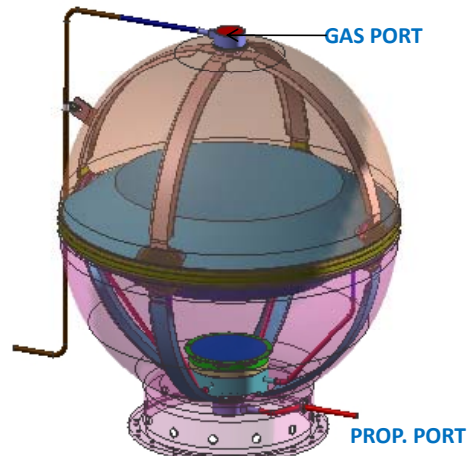
Standard parts: 6 Nos.

EBW Joints: 19 Nos.

Mass: 0.65 kg.



390L Propellant Tank:	
Fabricated parts:	120 Nos.
TIG welds:	35 Nos.
OTIG welds:	16 Nos.
EBW Joints:	65 Nos.
Mass:	22 kg.



30L Propellant Tank:	
Fabricated parts:	30 Nos.
TIG welds:	28 Nos.
OTIG welds:	11 Nos.
EBW Joints:	32Nos.
Mass:	5 kg.

Part-1

Raw materials & Fabrication aspects



Stainless steel	AISI 304 / 304L, AISI 430 / 440, 17-4 PH / 17-7PH
Aluminum alloys	AA 2026, AA 6061
Super alloys	Inconel – 600, Haynes-25, Columbium - 103
Titanium alloys	Ti6Al4V, TiCp
Others	Ingot iron, Dilver

Raw Materials



Haynes-25 tubes



SS 316L Bellow



Micro-switches



SS Spring



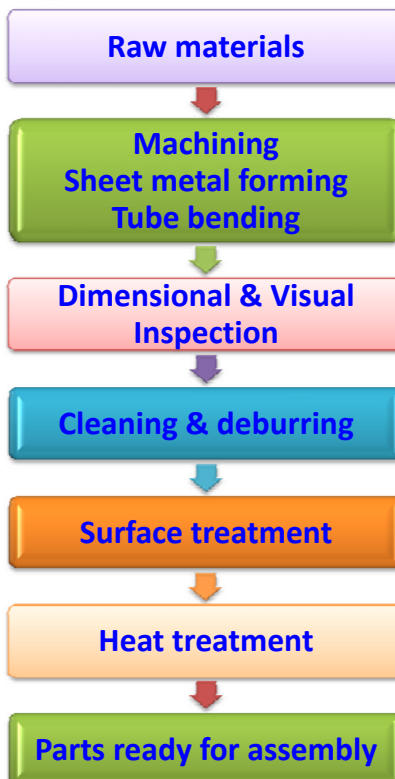
Filter

Standard parts



Propellant Tank Forgings

Fabrication of parts for components



Requirements

Difficult to machine materials:
Haynes-25, Inconel-600, C-103.

Dimensional tolerances: 5 - 10 μ

Geometrical tolerances: <10 μ

Surface finish: 0.4- 0.8 μ Ra

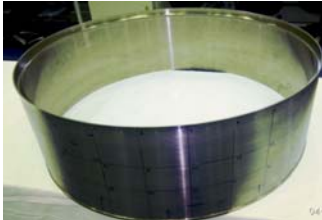
Burr free parts



Machining of Propellant tank parts



HEMISPHERE



INTERMEDIATE RING



TAB MILLED
SUSPENSION RING

Thin walled pressure vessel parts

Job size: Dia 400 mm-1150mm

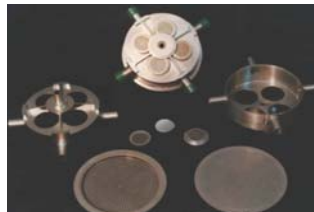
Wall thickness: 0.8 to 1.0 mm

Dimensional tolerances: 20-30 μ

Profile tolerances: < 50 μ

Surface finish: 1.6 μ Ra

Burr free parts



Sump Parts



Machining of Liquid Apogee Motor (LAM)



Processes involved

Material:
Chamber & Nozzle: C-103
Injector: Ti-6Al-4V

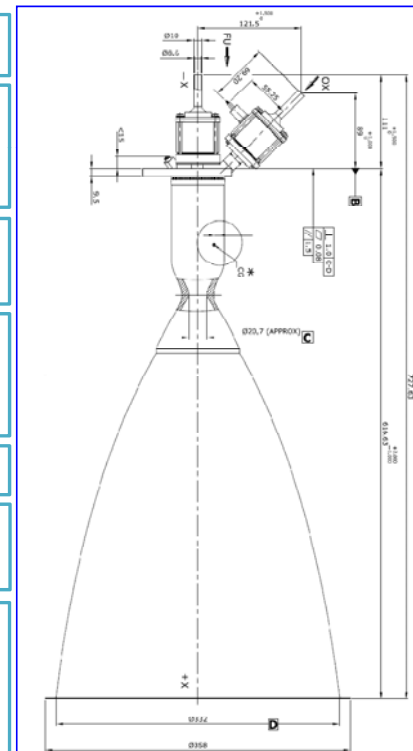
Sheet metal forming:
Deep drawing & Spinning

Critical requirement:
Nozzle divergent thickness:
varying from 1 mm to 0.4 mm

Chamber to Injector : EB welding

Surface treatment:
Silicide coating

Overall size:
Length: 616 mm
Throat dia: 20.7 mm
Exit dia: 332 mm



Part-2

Assembly & Testing



Assembly & Test Facilities for Components



Metal joining / NDT



Electron beam welding



Vacuum brazing



X-Ray / FP

Clean room

1,00,000 / 10,000 class



100 Class laminar flow tables

Ultrasonic cleaner

Particle counter

Mass spectrometer leak detector

Internal / external leak detection chamber

Precision microscope

Liquid filtration unit

Hot & cold chamber

Vacuum drying oven

Magnetiser

Coil winding machine

Testing



Flow test / electrical test unit

Pressure test facility

Precision spring testing machine

Vibration test facility

Thermo-vacuum test facility

Assembly & testing of components



Classification of Propellant tanks





Clean room



30m³ EBW Facility



Vacuum aging furnace

Assembly Operations

Chemical cleaning

Propellant Management Device (PMD) realization

Cleanliness verification and assembly of PMD with pressure vessel parts

Electron beam welding

Vacuum aging

Final stage machining

Non Destructive Inspection:
X-Ray
Ultrasonic Inspection
Eddy Current
Shearography



4-Axes CNC Mill-turn
Special purpose machine



X-ray facility



Ultrasonic inspection



Proof-pressure testing



Vibration testing



External leak testing



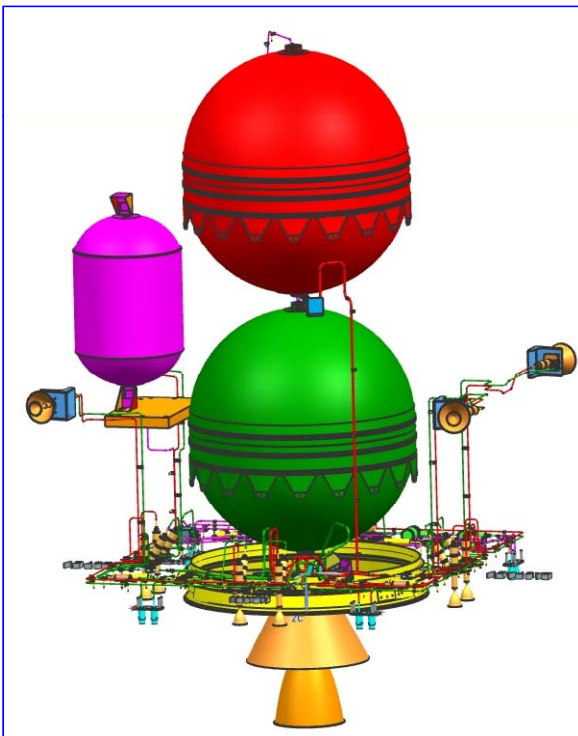
Functional testing

Part-3

System Integration & Testing

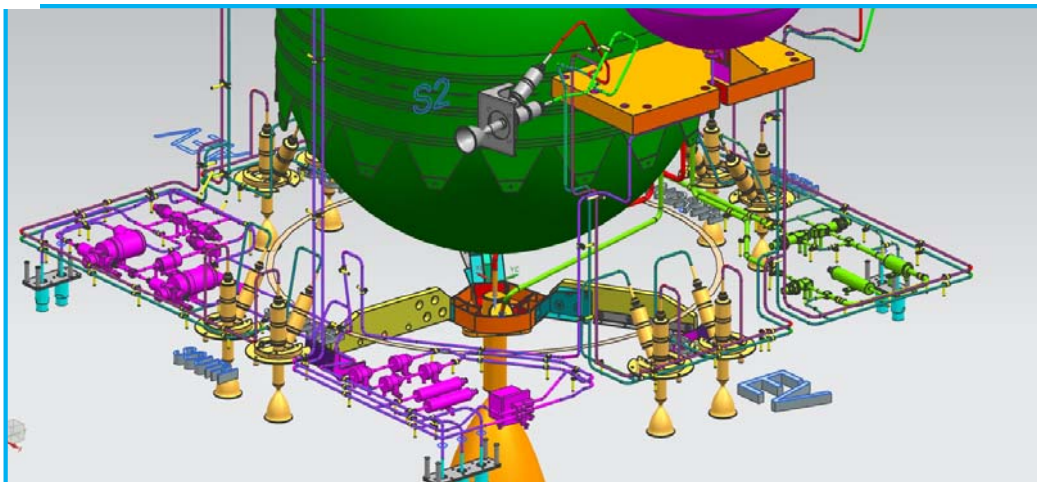


Propulsion Systems Integration & Testing



Operations involved:

- Pickling and passivation of tubes & integration elements
- Routing of tubing
- Integration of components on spacecraft structure
- Orbital TIG welding (200 - 400 joints)
- X-ray of weld joints
- Proof pressure test and leak testing
- Functional test & pressure hold tests



Pressure Regulator Module



Check Valve Module

Activities carried out in 1 lakh class clean room



Orbital TIG welding machine

Orbital TIG welding machine for welding tubing & inter-connecting components.

Pressurisation equipment to pressurise the entire system.



Pressurization equipment



Mass spectrometer leak detector

MSLD for characterising weld joints and component leak rates.

Remote console for safe operation of pressurisation unit



Remote Console



Electrical test console

Electrical ground support equipment for testing and monitoring system pressure & temperature.

Portable X-ray machine for X-ray of all high pressure joints.



Portable X- ray machine

Work-load for realisation of Mono-propellant propulsion system

Component	Qty (Nos.)	Machining hours	Assembly & testing hours	Integration & testing hours	Total hours
1N Thruster	08	5,100	1,700	400	7,200
Flow Control Valve (1N)	08				
11N Thruster	04				
Flow Control Valve (11N)	04				
Latch valve	04				
Fill & drain / vent valve	04				
System filter	01				
Propellant tank	01				

Work-load for realisation of Bi-propellant propulsion system

Component	Qty (Nos.)	Machining hours	Assembly & testing hours	Integration & testing hours	Total hours
10N Thruster	08	19,000	6,200	750	25,950
22N Thruster	08				
Thruster Valves	32				
LAM engine	01				
Pressure regulator	02				
Check valve	04				
Filter cum venturi	02				
Latch valve	03				
Fill & drain / vent valve	09				
System filter	02				
Propellant tank	02				

Annual work-load for 5 Mono-propellant & 10 Bi-propellant Propulsion systems

Project	Qty (Nos.)	Machining hours	Assembly & testing hours	Integration & testing hours	Total hours
Mono-propellant propulsion system	5	25,500	8,500	2000	36,000
Bi-propellant propulsion system	10	1,90,000	62,000	7,500	2,59,500
Grand total					2,95,500

THANK YOU

Global Satellite Industry Scenario

Opportunities for Industries

Dr. VS Hegde

Prof. Satish Dhawan Professor,

ISRO Hqrs., Bangalore

Email: vshegde@isro.gov.in

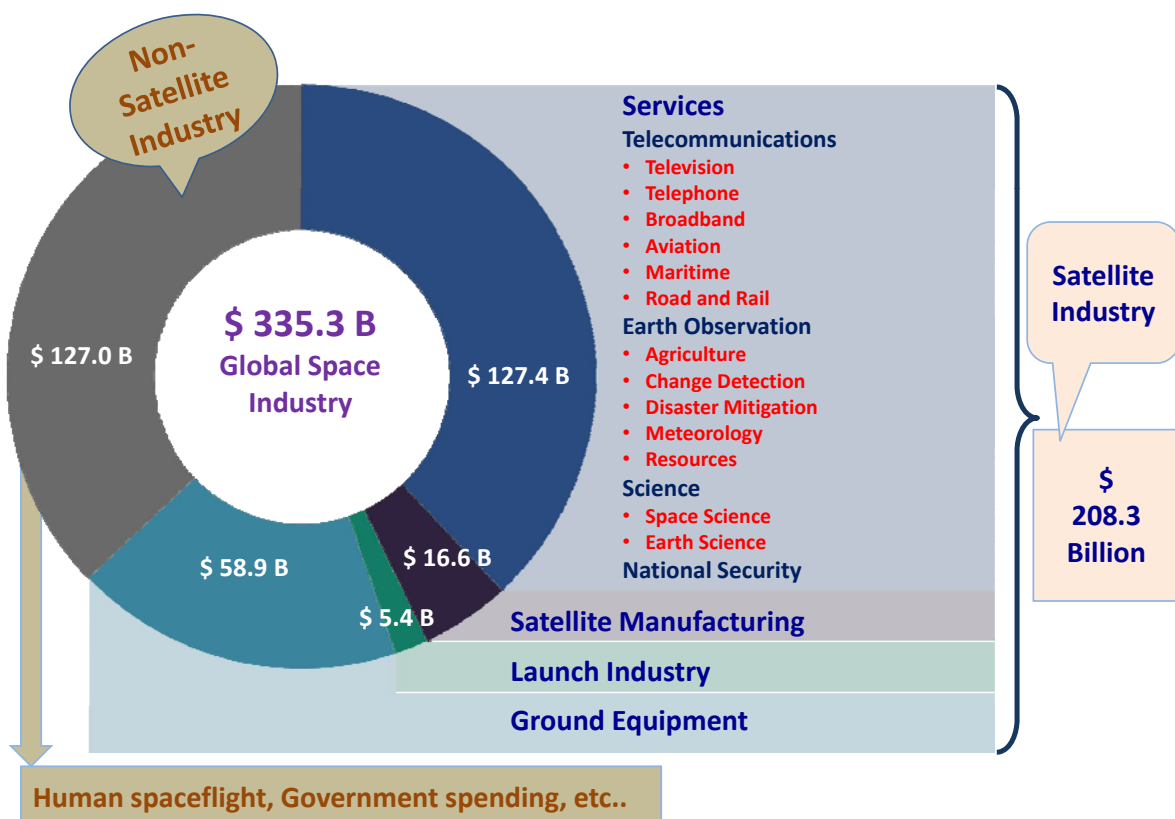
Conference on
**Enabling Spacecraft Systems Realization
through Industries (ESSRI) 2017**

ISRO Satellite Centre (ISAC)

Bangalore

14 July 2017

Global Space Industry

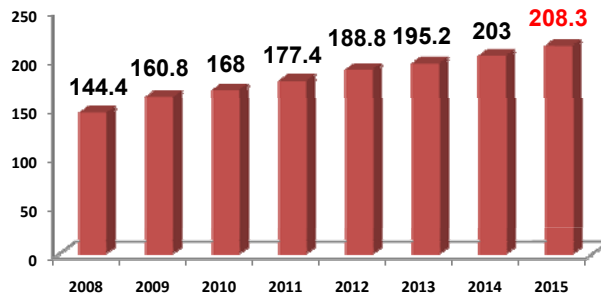
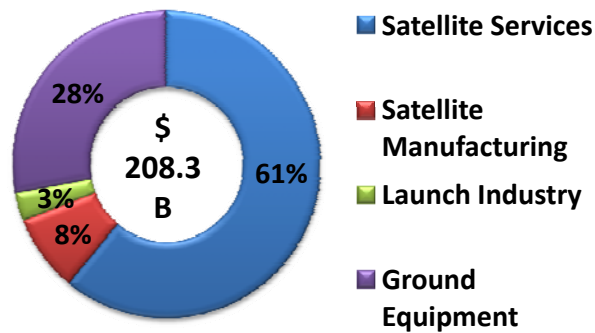


Global Satellite Industry

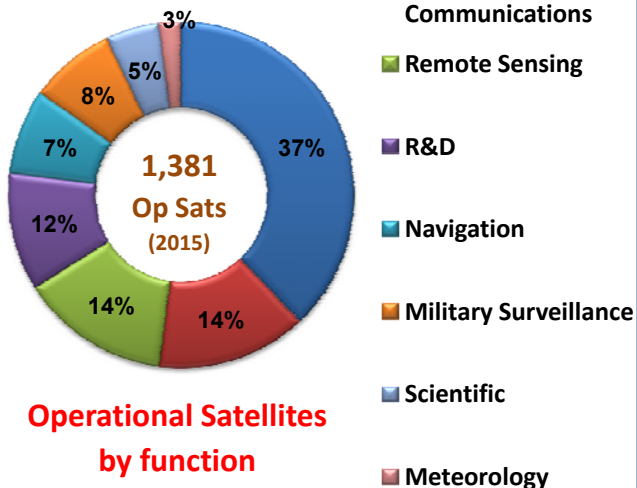
- Global Satellite Industry Revenue: **\$ 208.3 B** (2015); average growth rate **5%** during preceding 5 years
- Global satellite industry grew **3%** in 2015
- Ten-year global industry Growth: **2x** (from **\$ 106 B**)
- Average yearly USA market share: **>43%** of global industry

2008-2015

Global Revenue in B \$



Satellite Network



**Operational Satellites
by function**

As of year end 2015:

1,381 operating satellites

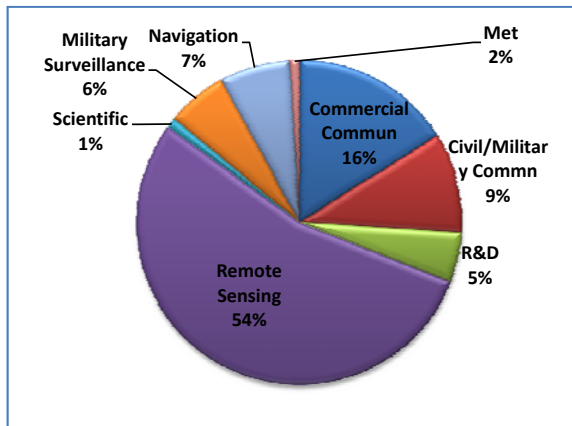
➤ **51% are communications satellites**

➤ **37% are commercial communications satellites**

59 countries operate at least one satellite

[some as part of regional consortia]

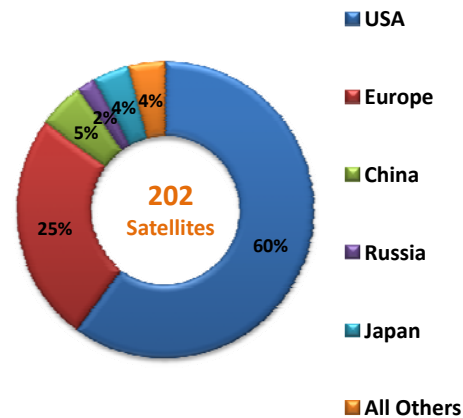
Satellite Manufacturing Industry



Spacecraft launched in 2015: 202
Does not include satellites built by Govt, Universities, Classified Satellites

- 202 satellites launched in 2015 compared to 107 in 2013 and 208 in 2014
- 108 Cubesats launched represented 53%
- Communication satellites represented 42% of revenue; Cubesats only 1% of revenue

Satellite manufacturing revenue in 2015: \$ 16.6 B



Spacecraft launched by country/ region of manufacturer in 2015

Does not include Satellites built by Govt, Universities, Classified Satellites

Small Satellite and Constellation

2016-2025 Forecast

- ~3600 Small Satellites expected to be launched
- EO largest number of units to be launched

EO satellites

Trend towards small satellites <500kg and constellations

- Planet Lab (100 satellite)
- Terra Bella (24 satellite)
- Spire Global (50 satellite)
- Black Sky Global (60 satellite)
- Satellogic (300 satellite)

Communication satellites

A large number of constellations planned, mainly for broadband from space

- Oneweb (700+ satellite)
- SpaceX (4500+ satellite)
- Boeing (1200+ satellite)
- Telesat (117 satellite)

Earth Observations (EO) - Trend

- Small, light, less expensive satellites transforming Earth Observation
- **New entrants are challenging the existing commercial data pricing strategies**
- Small satellite trends are shifting away from one-time stints, and moving towards widespread adoption, **enabled by constellations**

Satellite	World view-3	Pleiades-1A	Skysat	Dove	Most firms, since 2009, have been able to raise funds capital thru' series of funding* Constellation when fully deployed
Operator	Digital Globe	CNES/ Airbus	Skybox Imaging	Planet Lab	
Constellation	N/A	2	24 *	100 *	
Weight (kg)	2800	940	120	5	
Instruments	Multi Spectral Bands		Optical, Near Infrared Spectral Bands		
Resolution	0.3 - 3 m	0.5 - 2 m	~1 m (+1080 HD video)	3 - 5 m	
Re-visit	Up-to daily once		Up-to 5 times daily		

Earth Observation (EO) - Trend ..contd

Operators	High-Resolution (<1m)	Re-visit (<1 day)	Small Sat (<200 kg)	New Players have emerged • Typically founded, financed by IT/ Analytics/ Tech sector • Objective to provide real-time/ near real time imagery using internet • Smaller Satellites with lower costs of manufacture, launch & operation • Customer base is developing • Sophisticated data analytics on the ground
Airbus D&S	✓			
BlackBridge	✓	✓	✓	
DigitalGlobe	✓	✓		
DMCii	✓			
ImageSat	✓			
MDA				
Planet Labs		✓	✓	
Terra Bella	✓	✓	✓	
Spire Global		✓	✓	
Aquila Space	✓	✓	✓	
BlackSky Global		✓	✓	
Digital Globe/Taqnia		✓	TBD	
XPressSAR	✓		TBD	
Geoptics		✓	✓	
Hera		✓	✓	
PlanetIQ	✓	✓	✓	
Satellogic	✓	✓	✓	
				Operational
				Planned

Communications Satellites (Commercial) - Trend

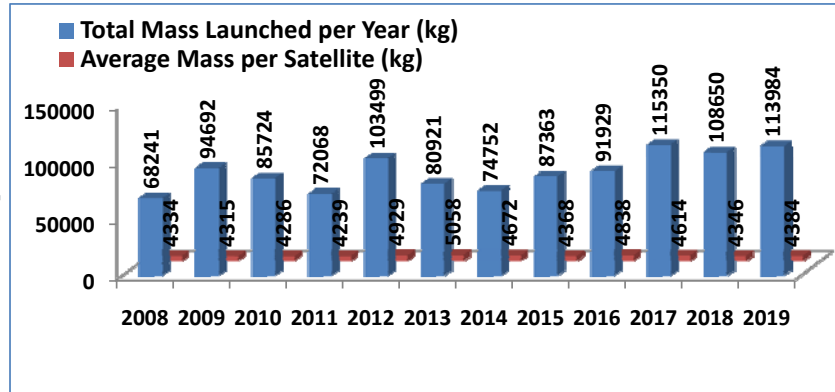
Mass (in kg)	Total (2017-26)	Avg/ Year (2017-26)	% (2017-26)
> 5400	115	12	50%
4201 - 5400	30	3	13%
2500 - 4200	61	6	27%
< 2500	23	2	10%
	229	23	100%

- Orders for 17 commercial GEO Satellites announced in 2015

- 11 orders won by US manufacturers

Trend in Satellite Mass Class in GSO (2017-26)

Total & Average Satellite Mass launched in GSO Orbit (2017, 18,19 Forecast)



Innovation in Spacecraft

- High Throughput Satellites (HTS) apply several technologies to maximize efficiency: frequency reuse, spot beams, on-board processing..
- HTS providing double or more throughput capability than traditional satellites, using same spectrum allocations
 - > 30 satellites with HTS capable payloads are currently in orbit; and, an equal number on order/ under manufacturing
 - HTS are mostly in GEO; 4 HTS launched to MEO in 2013 for O3b's constellation
- All-Electric Propulsion providing significant reduction in satellite weight, but requires more transit time to reach GEO
 - First order for electric propulsion communication satellite placed in 2012

Market for Satellite Navigation

GNSS market includes

- Consumer equipment tracked by SIA: Stand alone units and in-vehicle systems
- Other market segment - Chipsets supporting location based services in mobile devices; traffic information system; GNSS avionics in aircraft, maritime, surveying and rail

~7 Billion GNSS devices projected for use by 2022

\$ 78.1 B revenue in 2015

- \$ 47.1 B from other market segments
- \$ 31 from consumer equipment tracked by SIA

Consumer Broadband over Satellite

Keys to Success

- Comparable to terrestrial
 - In terms of speed, price
 - Available nationwide
- Maturation and combining of advanced technologies [frequency reuse, spot beams, on-board processing] defined new, high throughput satellites
- Substantial reduction in cost per unit of throughput
- Growing demand and customer confidence due to high data rates and reliable services

1990s

- Large constellation proposed, all cancelled
- Expensive technology
- Cost effective terrestrial competition

2000s

- Similar regional system proposed and deployed - Wildblue, Spaceway
- Technical success, test bed for new technologies, bandwidth cost reduction
- Acquisitions by established players

Present

- Five major systems today and expanding - Eutelsat Tooway, HughesNet, Viasat Exede, Inmarsat Global Xpress, O3b
- Four operators affiliated with established satellite operators
- 50% revenue growth over 5 years

StartUp Culture in Space activities

- **“NewSpace”- Emergence of Entrepreneurial Sector**
- **Nimbler approach to space related products and services : new technologies, cheaper components, technology focused finance group, business accelerators and space habitats**
- **Team Indus (Axiom Research Lab), Astrome, Exseed Space, Bellatrix Aerospace, Anant Technologies, .. are some “NewSpace” players active in India**

Emerging Opportunities in Indian Context

Digital India promises to transform India into a Digitally empowered society and knowledge economy

- **Important role of satellite broadband in Digital India**
- **Smart Cities** will have SatCom as important constituent
- **In Flight Broadband Connectivity**
- **Maritime** applications
- **EO applications** for the private sector

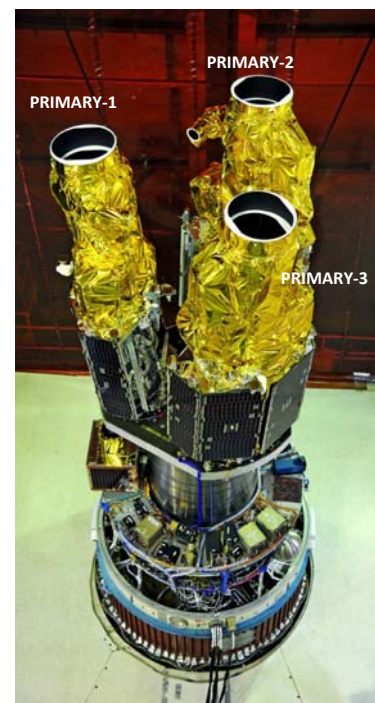
Satellite Launch Vehicles - Current Scenario

- Ariane 5 (Europe)
- Atlas (USA)
- Delta (USA)
- Dnepr (Russia)
- Falcon 9 & Falcon Heavy (USA)
- H-IIA (Japan)
- Minotaur-C (USA)
- Proton (Russia)
- PSLV
- Soyuz (Russia)
- Vega (Europe)
- Zenith 3SL (Russia/ Ukraine/ USA)

New Smaller Commercial Launchers - expected

- Rocket Lab Electron (USA)
- Fire Fly Alpha (USA)
- GOLauncher 1 (USA)
- LauncherOne (USA)
- Stratolaunch (USA)
- Super Strypi (USA)

Launching multiple satellites together (PSLV)



Conclusion and way-forward

some thoughts ...

- The potential of space market and the demand from customers is highly encouraging

Proactive Approach

- Flood market with products/ services
- Announce stepping-up of our production capacity to attract customers

Source

1. SIA 2016 State of Satellite Industry Report (Sept 2016)
2. FAA The Annual Compendium of Commercial Space Transportation
3. SpaceWorks 2016 Nano/ Microsatellite Market Forecast
4. FAA Commercial Space Transportation Report
5. Technical Information from ISRO and Antrix sources

*... thank you
for your kind attention*
vshegde@isro.gov.in



HINDUSTAN AERONAUTICS LIMITED

ESSRI 2017



HINDUSTAN AERONAUTICS LIMITED (HAL)

- A Defence Public Sector Undertaking (DPSU) under Ministry of Defence
- Founded by Late. Seth Walchand Hirachand in 1940
- 38th Position among the top 100 Aerospace industries of world
- India's Flagship National Aerospace Company
- A Navaratna Company since 2007
- Engaged in design, development, manufacture, repair and overhaul of aircraft, helicopter, engines and related systems like avionics, instruments and accessories
- Major contributor to ISRO programmes



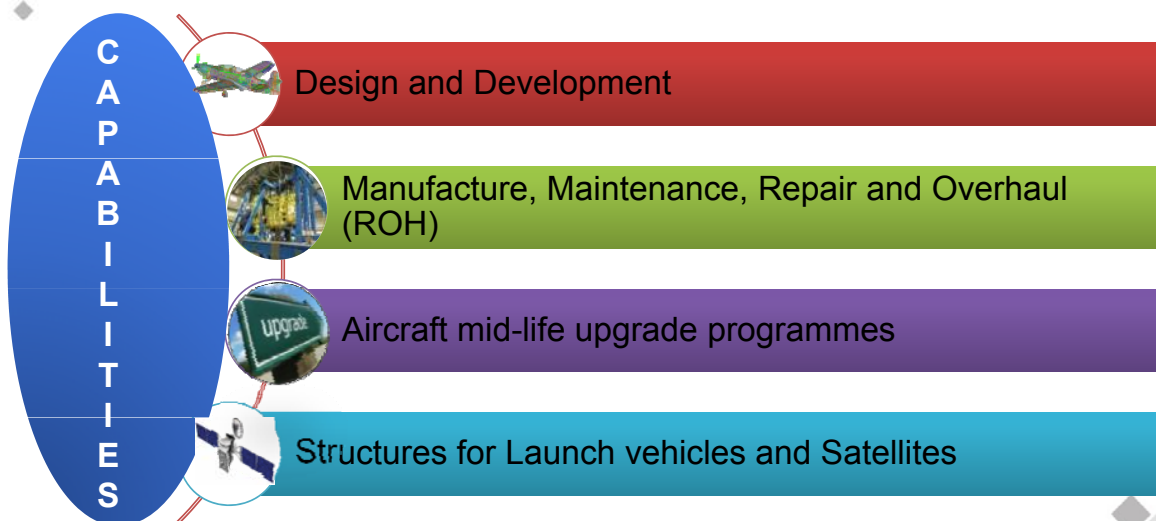
Seth Walchand Hirachand



H.A.L. Main Gate 1942



HINDUSTAN AERONAUTICS LIMITED (HAL)



ASSOCIATION WITH SPACE PROGRAM

- HAL's association with Space Program dates back to **early 70s**.
- ISRO partnered with HAL for realisation of light alloy structures
- A separate facility for fabrication of structures for satellites and launch vehicles was conceptualised in early 80s
- **Aerospace Division commenced operation in 1988**
- **Dedicated to the Nation** by the then Prime Minister, Shri Chandrasekhar on **19th April 1991**



Inauguration of Aerospace Division Administrative Building by Air Marshal MSD Woolen, PVSM, VM(Retd.), Chairman, HAL on 25.3.1988.



Aerial view of Aerospace Division



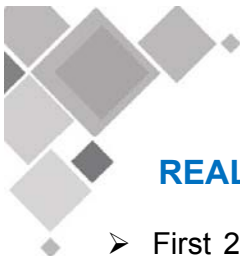
ASSOCIATION WITH SATELLITE BUILD

- Built the structural assembly of **India's first satellite Aryabhata**



Aryabhata

- HAL has produced & delivered 106 Satellite Structures till date



REALISATION OF SATELLITE STRUCTURES AT HAL

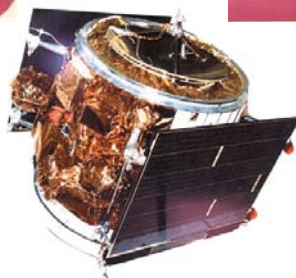
- First 20 structures were produced at Aircraft Design Bureau & Helicopter Design Bureau of HAL (Aryabhata to IRS-1B from 1972 till 1988).



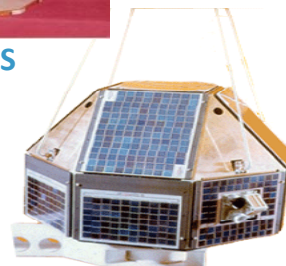
Bhaskara



SROSS



APPLE



RS



REALISATION OF SATELLITE STRUCTURES AT HAL

- 86 structures produced at Aerospace Division till date
First Structure - INSAT-2A in Jan 89
Latest structure - INSAT-3DS in Jun 17



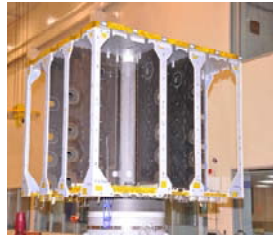
INSAT-2A



INSAT-2E



Cartosat

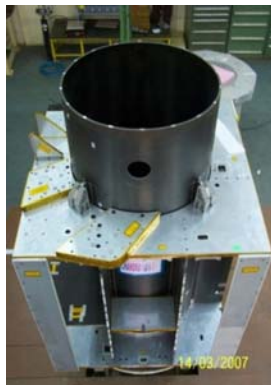


Astrosat



GSAT-11

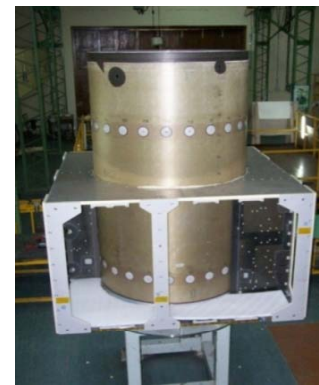
SATELLITE STRUCTURES FOR DEEP SPACE PROGRAM



Chandrayaan-1



Mangalyaan



Chandrayaan-2



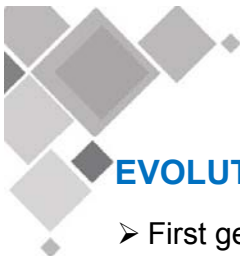
STRUCTURES FOR FOREIGN SATELLITES



Hylas

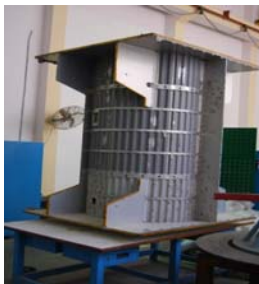


W2M



EVOLUTION OF TECHNOLOGY FOR SATELLITE STRUCTURES

- First generation satellites – structures of Aluminium alloy machined frame built by rivetting.
- Stiffened cylinder construction for weight and cycle time reduction.
- Moved to Corrugated Aluminium Alloy construction.
- Next generation satellites - metallic sandwich construction & bonding as the primary process.



INSAT-2E



INSAT-3A



SRE



EVOLUTION OF TECHNOLOGY FOR SATELLITE STRUCTURES

- Present Satellite Structures are CFRP Sandwich Construction.



I-1K



I-2K



I-3K



I-6K

- Structure weight vs Spacecraft weight reduced from 10% (INSAT-2A) to 5-6% by change in design, materials and processes.

HAL CAPABILITIES – AEROSPACE COMPOSITE DIVISION

- Realisation of CFRP cylinders & Primary Bonded Deck Panels



Primary Bonding facility



Autoclave



CFRP cylinder



Frame Bonding

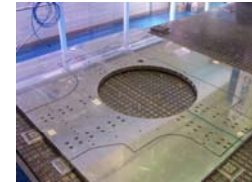
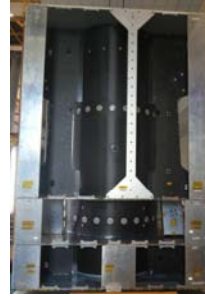


Deck panel



HAL CAPABILITIES – AEROSPACE DIVISION SATELLITE SHOP

- Structural assemblies for I1k, I2k, I3K, I4K and I6K class of satellites upto 5000 mm in height
- Machining of sandwich panels up to 5500 mm in length



HAL CAPABILITIES – AEROSPACE DIVISION CNC & PROCESS SHOP

- Machining of the satellite interface rings with intricate configuration and thin wall sections up to 5500 mm in diameter.



- Facilities for chromic and sulphuric acid anodizing, chemical milling, cadmium plating, pickling & passivation, vacuum impregnation and painting of hardware.

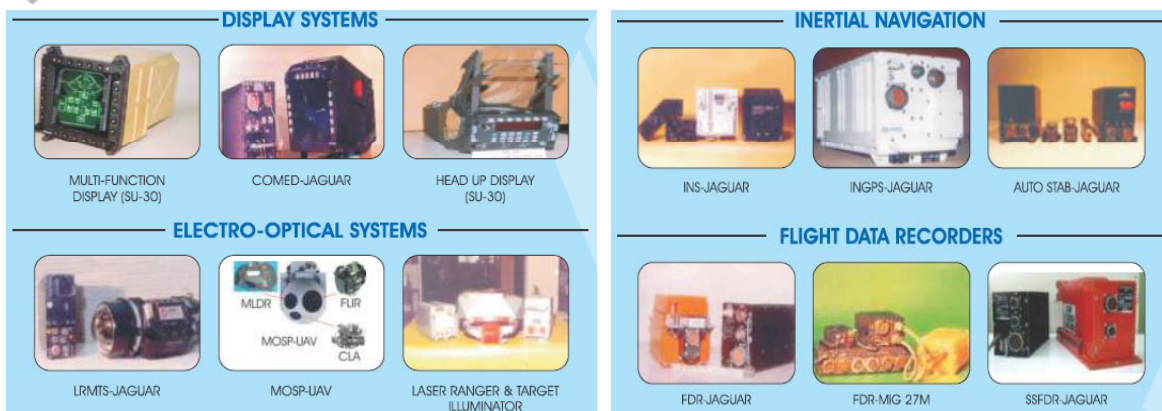




HAL CAPABILITIES – LUCKNOW DIVISION



HAL CAPABILITIES – KORWA DIVISION



- Critical process and assembly technologies in areas of display system, mission & recording system, inertial navigation system & electro-optical systems



HAL CAPABILITIES – HYDERABAD DIVISION



- SLRDC has signed an MoU with SAC (Space Application Center) Ahmedabad for mutual co-operation on future aerospace development

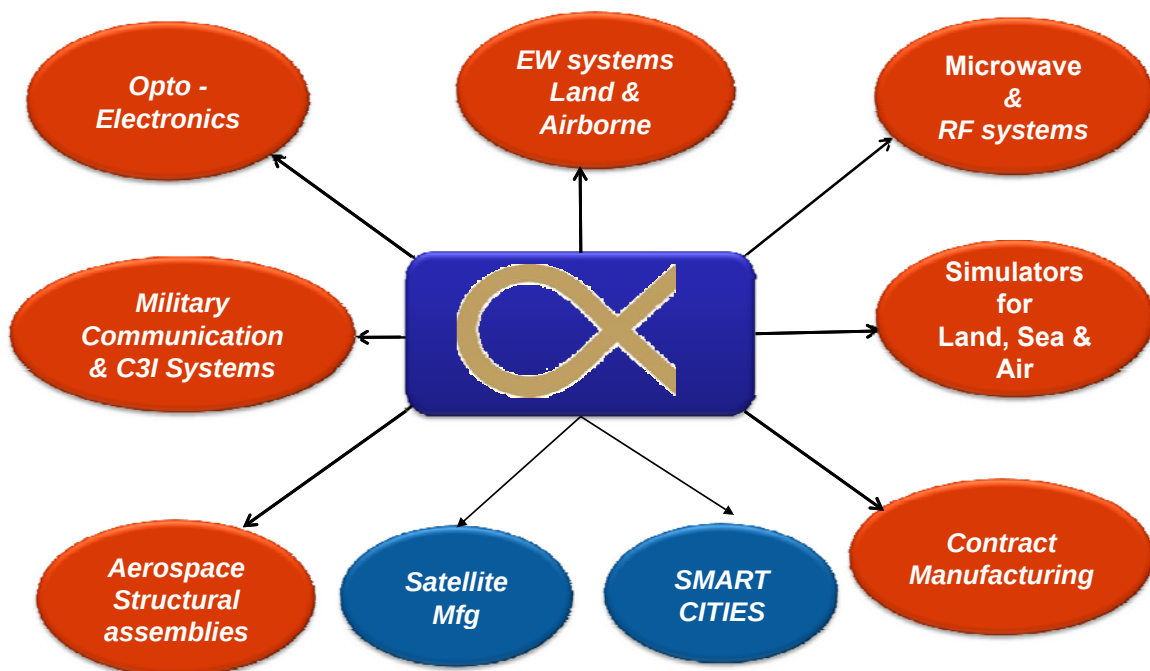
THANK YOU



Brief on ADTL

- ❖ Started in 2003 HQ in Bangalore
- ❖ Focus on Defense Electronics and Aerospace for Military & Homeland Security
- ❖ Strategic Joint Ventures & Collaborations in niche technological areas
- ❖ Main thrust on R&D, Co-development, Manufacturing, Integration & Technical support
- ❖ Progressive growth in business to Rs. 400+ Crs.
- ❖ Certifications Accredited: AS 9100C, CEMILAC, DRDO labs, DST as R&D house

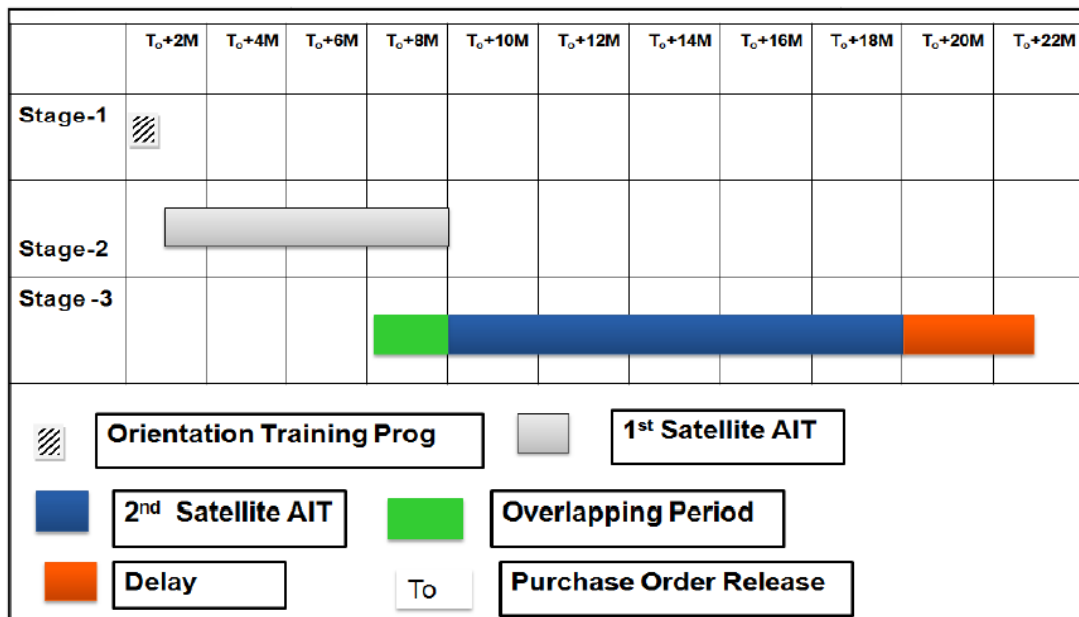


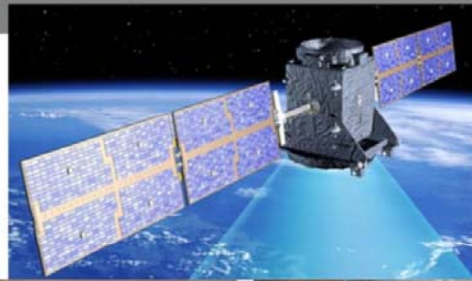




- ❑ In line with the vision of ISRO, for the Make In India concept, ADTL, with domain knowledge in Aero space & electronics, expanded its focus into space industry. ADTL aims to become a long term partner to ISRO in building Indian Satellites, using ISRO technologies.
- ❑ ADTL received order for Assembly, Integration and testing (AIT) activities of two number of Standard bus satellites of IRNSS.
- ❑ AS per contract , ADTL has contributed 50 Engineers and technicians to ISAC (Trained totally 70 people in AIT activities) who are soon completing the first satellite planed to be launched in August 2017.
- ❑ For the second satellite, the preparatory AIT activities have started. The supervision of ISRO/ISAC will be reduced compared to first satellite and ADTL will perform all AIT activities to meet the highest standards of quality and workmanship, and deliver the services to ISRO

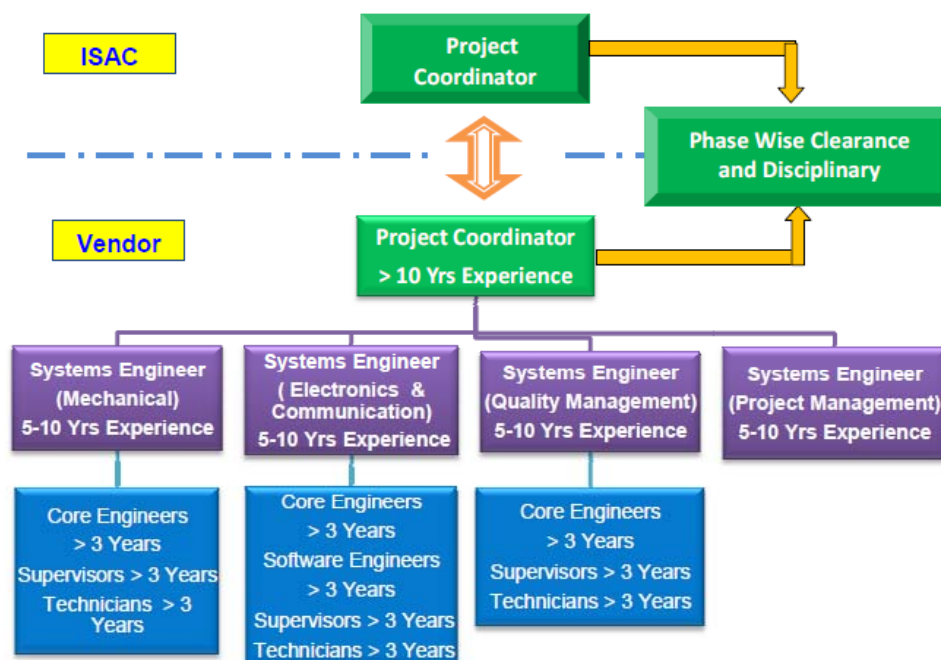
- Subsequently, ISRO plans to outsource satellites, on an end-to-end basis and carry out assembly, integration and testing of spacecraft at ISAC/ISITE campus through private partnership, under separate contracts.
- After successful completion of integration of the two satellites, ADTL will invest in facilities and manpower, to take- up satellite fabrication/ Assembly and testing activities.
- ADTL with technical support from ISRO, would contribute in building satellites, on an end-to-end basis and carry out assembly, integration and testing of spacecraft at ISAC/ISITE campus under a separate contract.
- ADTL focus on Quality from the time of its inception, has been well aligned with the Vision to develop and manufacture products for Defence and Aero space , and now for space craft market.

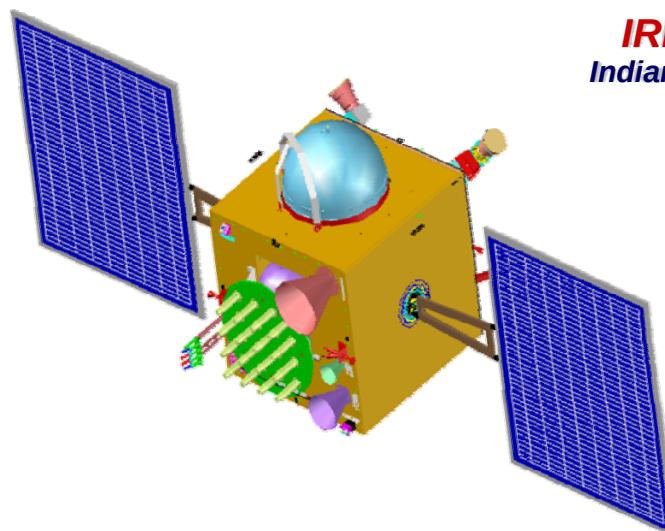
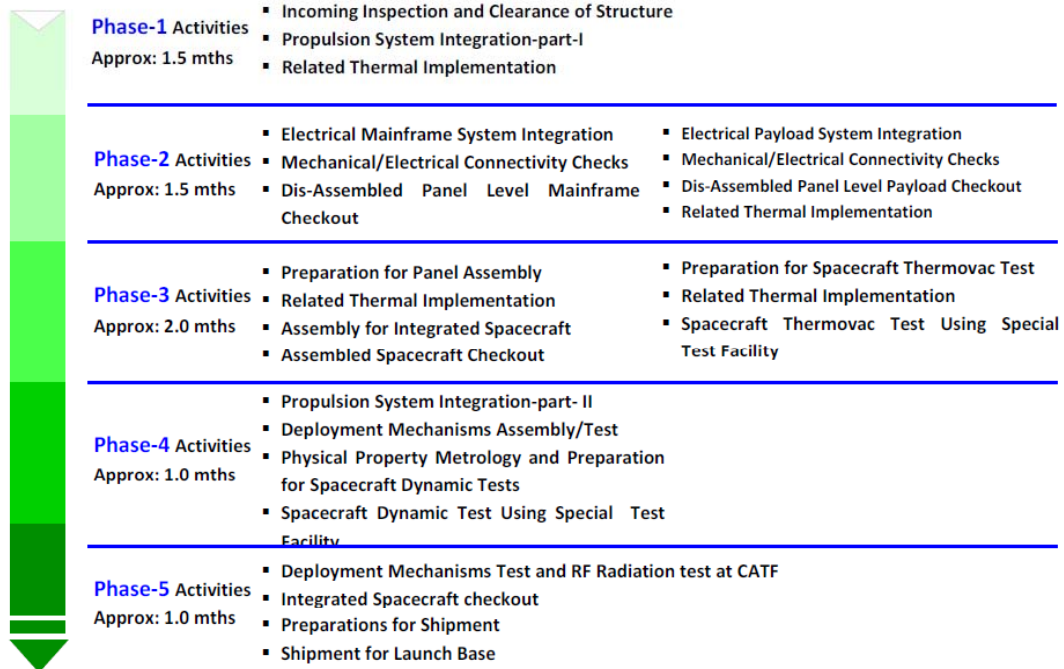




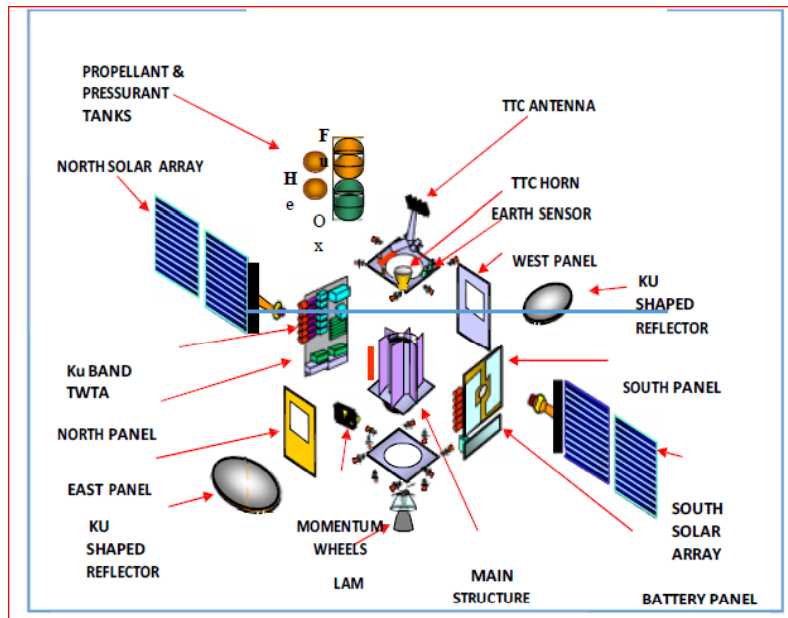
Siging of Contract by Padma Shri Dr. M. Annadurai, Director-ISAC, Bengaluru and Col. H.S. Shankar, VSM (Retd), CMD, Alpha Design Technologies, Bengaluru for Systems Assembly, Integration and Testing (AIT) of Standard Two Numbers of ISRO Satellites

AIT Project- Project Management Structure





IRNSS Spacecraft
Indian Navigation Satellite



ISRO-ALPHA PARTNERSHIP

IRNSS being de-containerised at clean room



Source: ISRO Website - www.isro.gov.in

IRNSS at Clean Room



Source: ISRO Website - www.isro.gov.in

ISRO-ALPHA PARTNERSHIP



Satellite Launch



Source: ISRO Website - www.isro.gov.in

NavIC: INDIAN REGIONAL NAVIGATION SATELLITE SYSTEM (IRNSS)



- Seven satellites in Geostationary and inclined Geosynchronous orbits
- Provides highly accurate position, velocity and time information in real time to a variety of vehicles
- Position accuracy of better than 20 metres
- Data with good accuracy for a single frequency user with the help of Ionospheric corrections

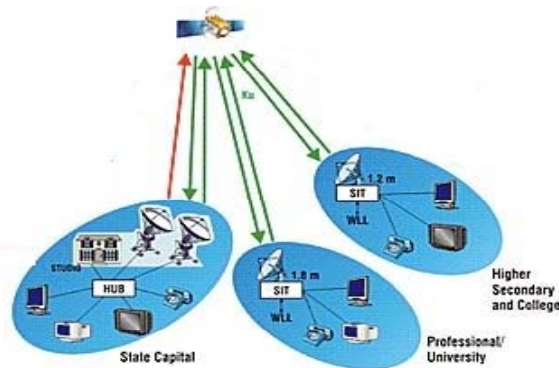
- All weather operation on a 24 hour basis
- Coverage over India and about 1500 km around it
- **IRNSS-1A, 1B, 1C, 1D, 1E, 1F and 1G Satellites already in Orbit**

Other Applications

Surveying and Mapping, Precision Farming, Timing, Transport, Marine, Location based Services, Disaster management, Personal navigation, Mining, Recreational applications, etc

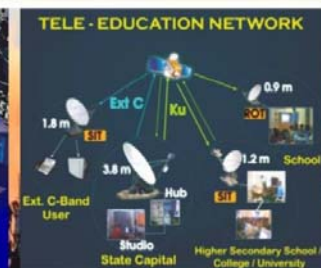


Revival of North Eastern States' Tele-Education Networks

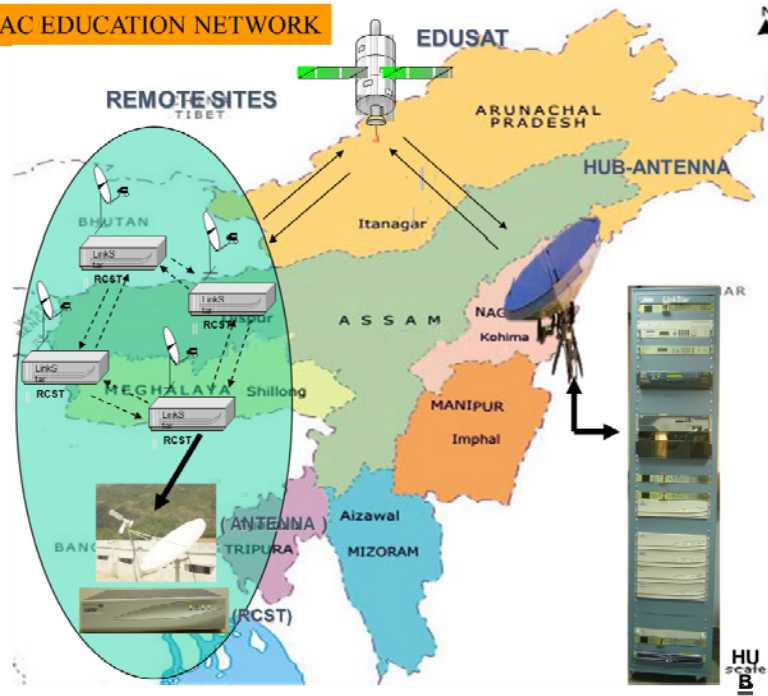


Revival and Sustenance of North Eastern States' Tele-Education Networks

- Above program implemented by BEL during 2005-2010. Now defective / Obsolescent / Needs Upgrades.
- Part of EDUSAT Program.
- Total 325 Satcom STWS – Ku Band Hub, Teaching End & Remote Satellite Terminals (SITs).
- Recommissioning Hubs, Teaching Ends & SITs.
- About 2000 equipment to be replaced, returned, re-integrated, upgraded, networked.
- Work started.
- Will be completed –
 - Phase 1 : April 2017
 - Phase 2: July 2017



NESAC EDUCATION NETWORK



MSS GROUND NETWORK

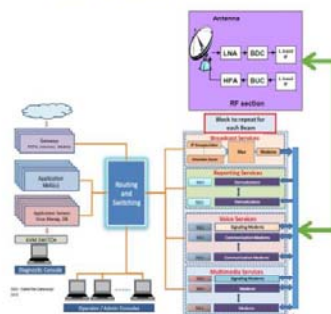
Alpha Design Technologies received an order from SAC, Ahmedabad for Supply and Integration of MSS Hub Baseband system

The HUB station will be a centralized control system for the multi-beam MSS services network. It should support four different services i.e. one-way reporting, two-way voice communication, multimedia and broadcast services. All network operations in all five beams are to be managed and controlled by the MSS HUB. It also provides the required interfaces between MSS systems and PSTN/terrestrial network.

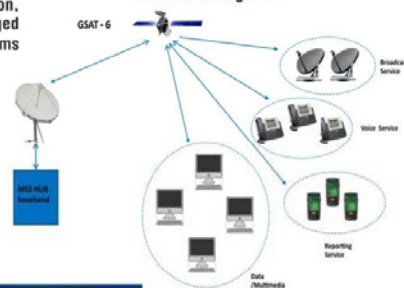
The HUB consists of three main component sections.

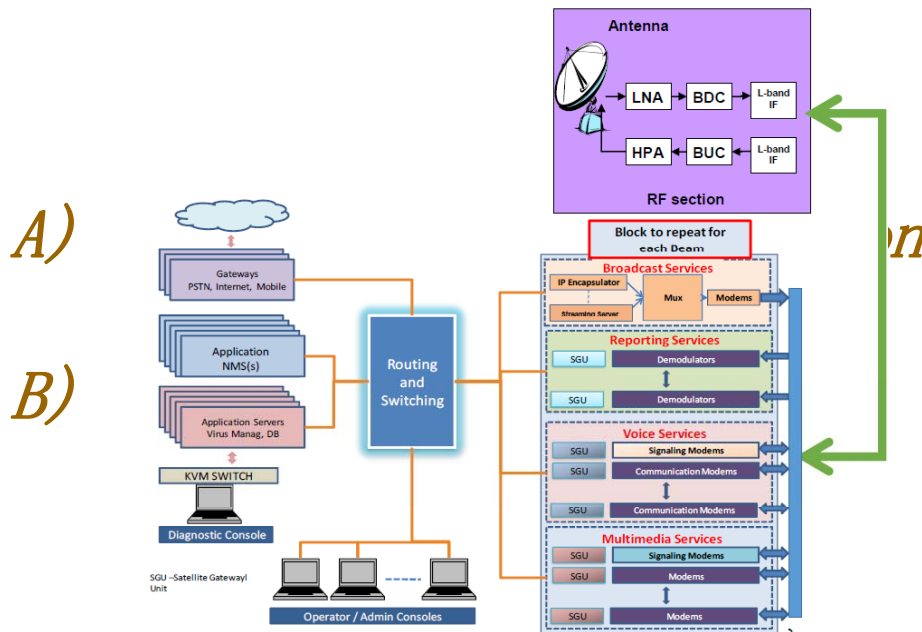
1. C-band antenna with RF section
2. Base band section
3. Terrestrial gateways – SMS, PSTN, GSM, Internet

MSS Hub System Configuration



Network Diagram

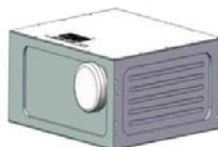




Two Way MSS Terminal for Vessel Tracking

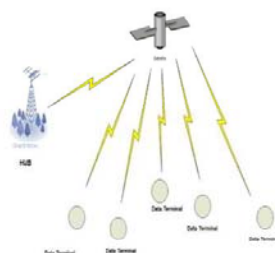
FEATURES

- Customer: Space Applications Centre (SAC), ISRO
- Scope of the Project: Development & Manufacturing of MSS based Two-way Data Terminal for Vessel Tracking which is an S-band transceiver with two-way data communication capabilities at programmable bit rates.
- Features:
 - Low-cost
 - low-power consumption
 - long standby time
 - Ruggedized for maritime climate
 - Mass producible
 - TDMA Protocol for communication with Satellite Hub
- Hardware & Interfaces:
 - The hardware comprises of Base-band processor, modem with RF transceiver & an RF Front-End module
 - GPS, Wifi (Wireless LAN 802.11 Std) & Bluetooth interfaces

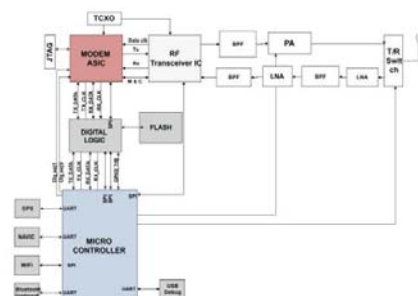


SYSTEM CONFIGURATION

- Mobile satellite services are known for offering extensive coverage and tracking solutions irrespective of geographic conditions.
- Two Way MSS Terminal for Vessel Tracking is a maritime solution for tracking bulk numbers of vessels on Indian waters and their behavioral pattern from a control center.
- It is a secure way as the communication channel doesn't use the present dedicated wireless networks for obtaining the location of the vessels under control which in turn can assist the Control Centre Staff in identifying vessels of interests so that necessary prevention measures can be taken as part of a pro-active approach.



BLOCK DIAGRAM



1. Hardware Development of Of IRNSS Receiver.
2. PC based SDR software development for GNSS signal processing.
3. Implementing simulink models on FPGA and obtaining the MATLAB Code for Tracking, Carrier acquisition and position estimation
4. Converting the MATLAB Code to VHDL Code for the Target FPGA
5. Refining the Algorithms for better Position accuracy using RTK methods



What are Expectations of Industry

Industry Contribution

Structure and Composite Assembly

Heat Pipes

Composite Substrates

Mechanism and Precision Fabrication

Rigid Optical Solar Reflectors

Solar Panels and Batteries

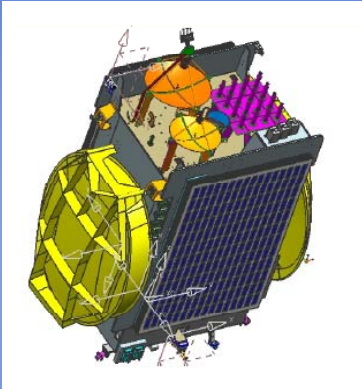
RF Systems

Electronics Systems

Hybrid Circuits

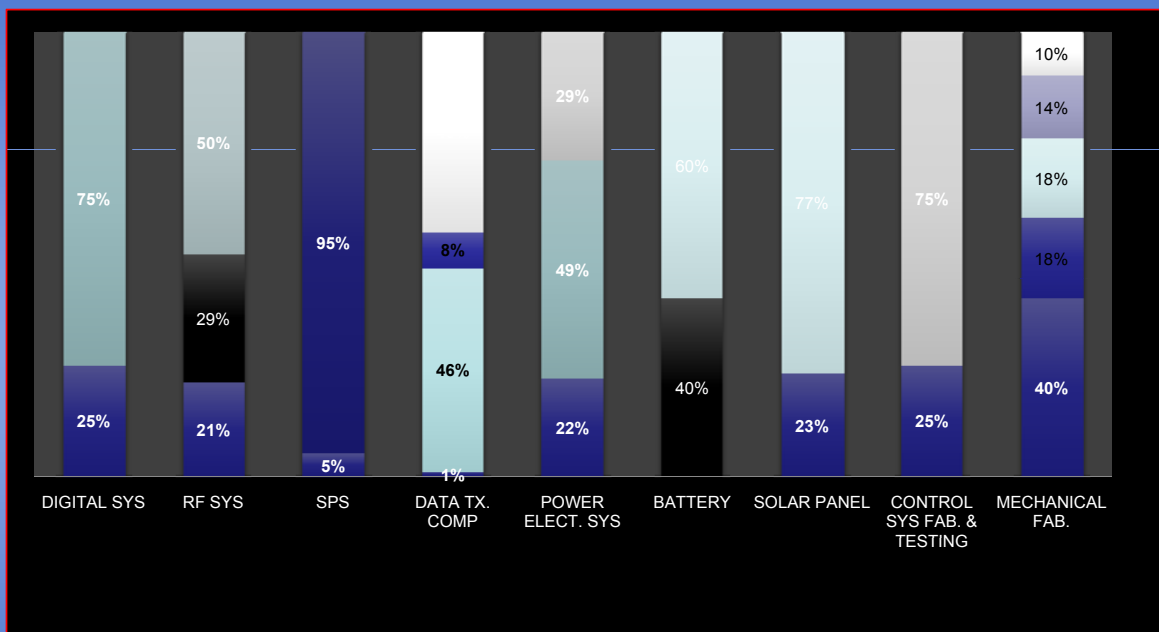


Indigenisation



RF Systems
Dual Gridded Reflector (DGR)
Propulsion Tanks and Thrusters
Nickel Hydrogen Batteries
Electro-optic Sensors
DC-DC converters and Hybrid Circuits
Temperature Sensors and Heaters
Optical Solar Reflectors
Heat Pipe Embedded Panels

INDUSTRY CONTRIBUTION



Overall Industry contribution is 70%

Facilities



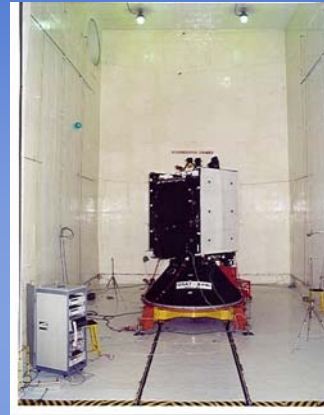
Compact Antenna Test Range



Satellite Integration Facility



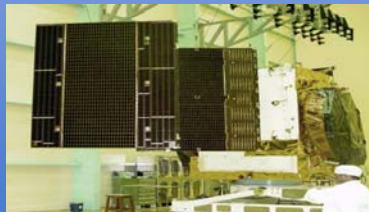
HMC Fabrication Facility



Acoustic Test Facility



Thermo-vacuum Chamber



Solar Panel Deployment



Vibration Test Facility



Thank you



“Enhanced Engagement: Concept to Commissioning – Centum Perspective”

Sandhya Thyagarajan

General Manager, Strategic Electronics Business Unit,
Centum Electronics Limited, Bangalore



Contents

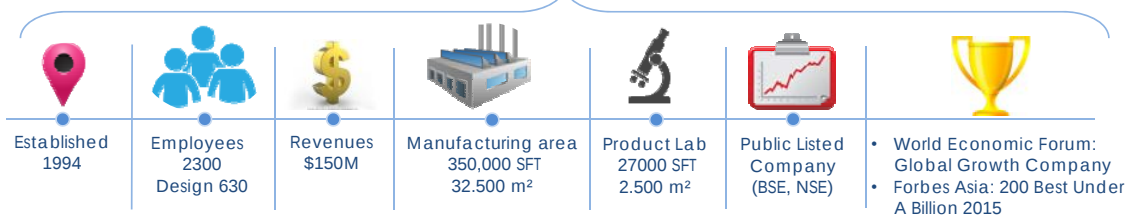
- Centum Overview
- Products and Platforms
- Space Journey
- ISRO Industry Partnership Models
- Conclusion



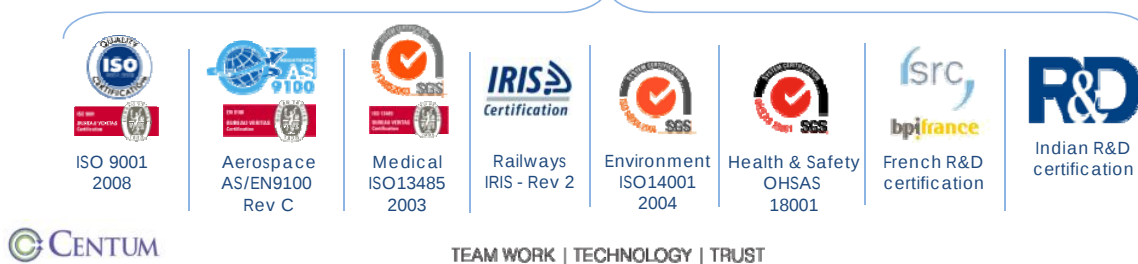
TEAM WORK | TECHNOLOGY | TRUST

Fast Facts

Overview



Systems and Certifications



Industry Segments

DEFENCE & AEROSPACE



TRANSPORT



INDUSTRIAL



SPACE



MEDICAL



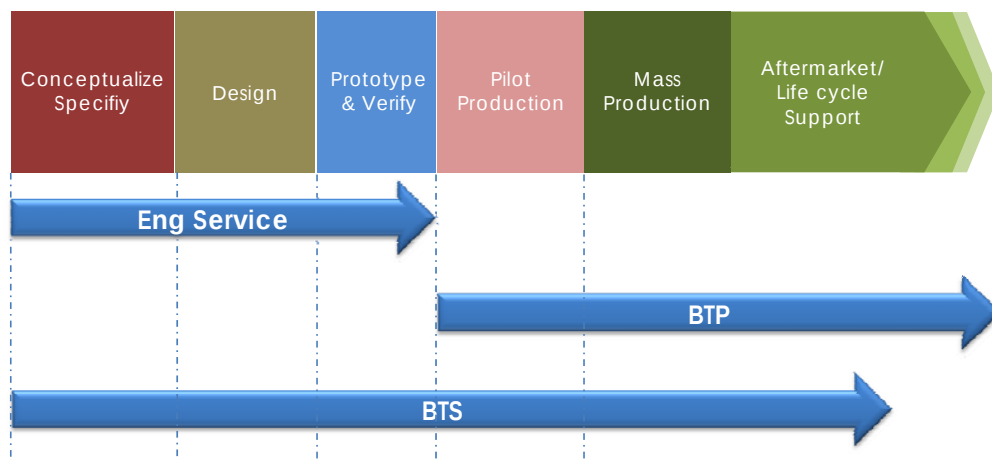
COMMUNICATION

Customer Portfolio



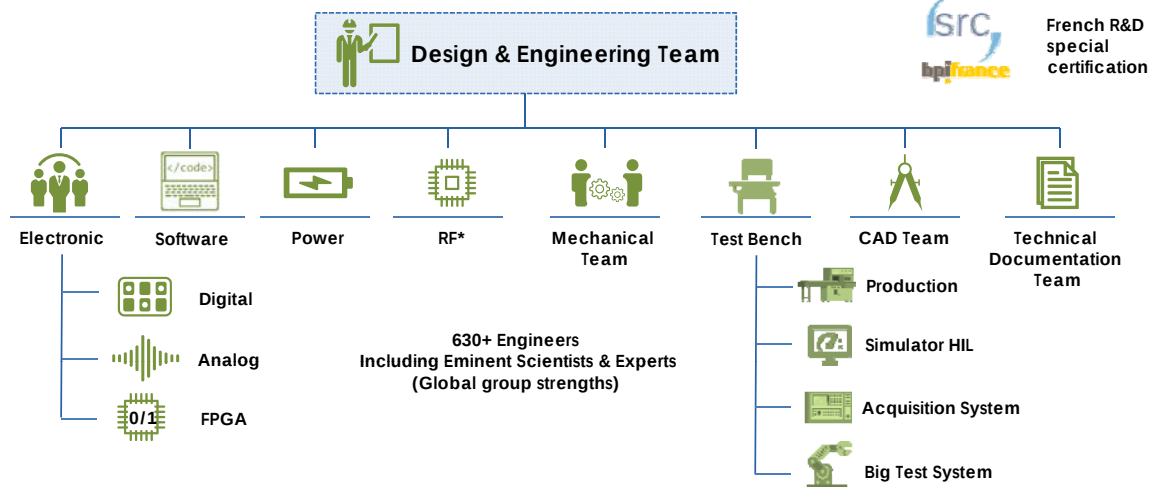
TEAM WORK | TECHNOLOGY | TRUST

Complete Product Realization Capability



TEAM WORK | TECHNOLOGY | TRUST

Design & Engineering Capabilities



Wide-Range of Design & Engineering Capabilities



TEAM WORK | TECHNOLOGY | TRUST

Aerospace & Defense – Product realisations



Li-Ion Battery Management System



High Safety Data Processing



Alternate Extension Control Module



High Performance Embedded Computer for A400M



Power Converter 28/270 Vdc 2kW



TCAS for Boeing



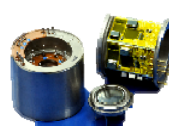
Data recorders



EW Power Supply



Camera Electronics

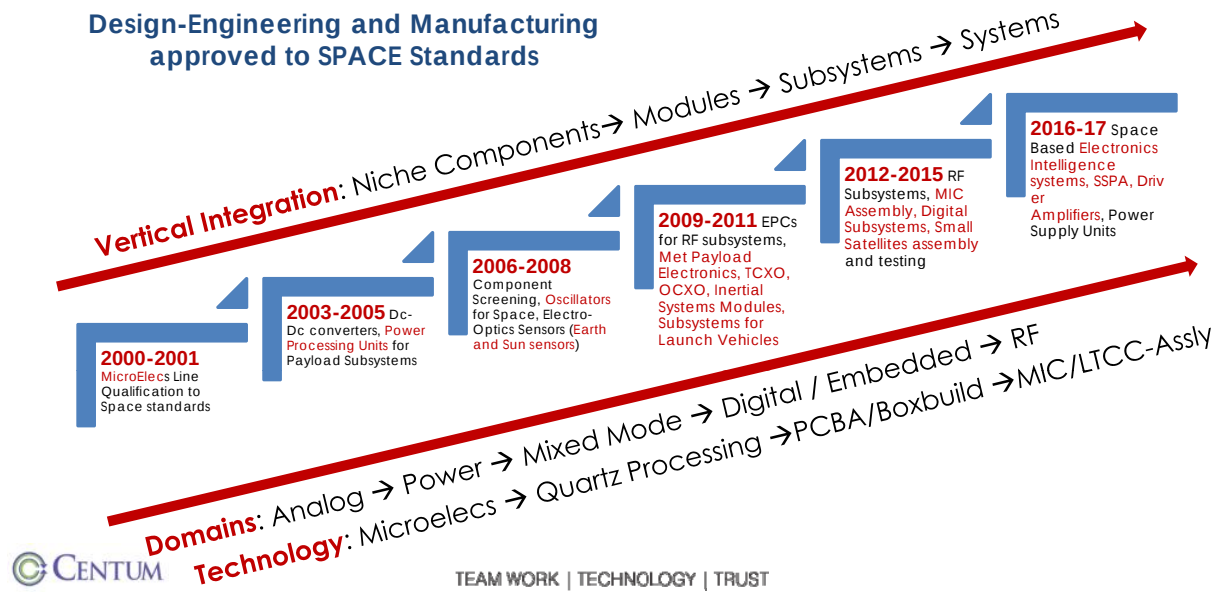


Missile Electronics



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Centum Space Journey



Space Platform Experience

COMMUNICATION



NAVIGATIONAL



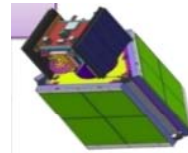
METEOROLOGICAL



SMALL SATELLITES



RADAR IMAGING



LAUNCH VEHICLES



BTP → BTS
Partial → Full Turnkey

Centum has more than 350 parts (modules, subsystems) in every ISRO mission since 2005

MARS ORBITER



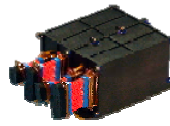
Space- Product realizations



SCUBI



Transducer
Excitation Module



Alternate
Extension Control
Module



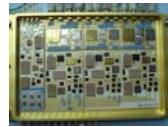
Data Acquisition



Earth Sensors



Power Systems



Microelectronic Modules



Microelectronic Modules



Tile Control Electronics



Space Grade Oscillators



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Space Products Portfolio



TEAM WORK | TECHNOLOGY | TRUST

Thrust on Indigenization

“Meet & Beat - Technically & Commercially” Centum Mantra for Indigenization

- Significant portion of Centum’s delivery to Space segment is an Indigenization/customization effort.
- Customised requirements of ISRO are met using the Indigenous design and qualification (many times more stringent than the ones in the international market)
- Centum’s access to a large supplier base across the globe, highly efficient business processes and experienced technical manpower, coupled with the Manufacturing Capability – comparable to the best in the world, has resulted in huge Forex saving to ISRO



TEAM WORK | TECHNOLOGY | TRUST

Centum – Growth Plans

- Centum is continuously leveraging its design strengths, manufacturing assets and best management practices to deliver the space electronics hardware to demanding requirements of ISRO.
- Regular investments in technology and people is crucial to be an international player in space segment.
 - Standardization and Miniaturization of DC-DC converters
 - Next generation – modules in Inertial Navigation area
 - Increase the density of the electronics in subsystems packaging using different technologies
 - Digital and Embedded
 - RF and Microwave
 - Engage with International Space Customers and develop hardware for ISRO



TEAM WORK | TECHNOLOGY | TRUST

ISRO-Industry Partners

- In the country, ISRO has the best and the robust mechanism of developing its Industry partners, which is clearly a model which the other sectors can emulate.
- With significantly large number of missions planned in the next 5 years, the need for having strong Industry Partners is the highest ever for ISRO.
- The increasing maturity of the Indian Space Industry will also help ISRO outsource more and enhance the delegation levels to its Industry partners.
- If the Industry has to step up, ISRO will have to let go many of its intermediary functions.
- This may also necessitate a change in the business model including the contractual rule book. For technology intensive, lumpy and risky business like space, the usual 'L1-bidder' business is not the most suited model.



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Classical Approach v/s New Approach of Building Industry partners

Classical Model:

- “Routine work of ISRO – offloaded to Industry” as an initiative in Capacity Building to achieve volumes that are not possible to meet by ISRO without significant increase in its manpower and infrastructure.

ISRO • This model is built upon the transfer of proven and reliable technology from ISRO based on the long term partnership. • This has handholding by ISRO through supervision and infrastructure. • This will elevate the Vendors in the space program to one level.	• Dependency on ISRO for orders • Hesitancy in building the infrastructure leading to long cycle to achieve the complete know how. • Single customer risk – resulting in lack of Investor's confidence • L1 - risk INDUSTRY
--	--

Job Work and BTP mode



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Classical Approach v/s New Approach of Building Industry partners

New (Empowered) Model:

- Encourage Industry partnership based on their space products and services.
- Provide room for Inventive risk taking.

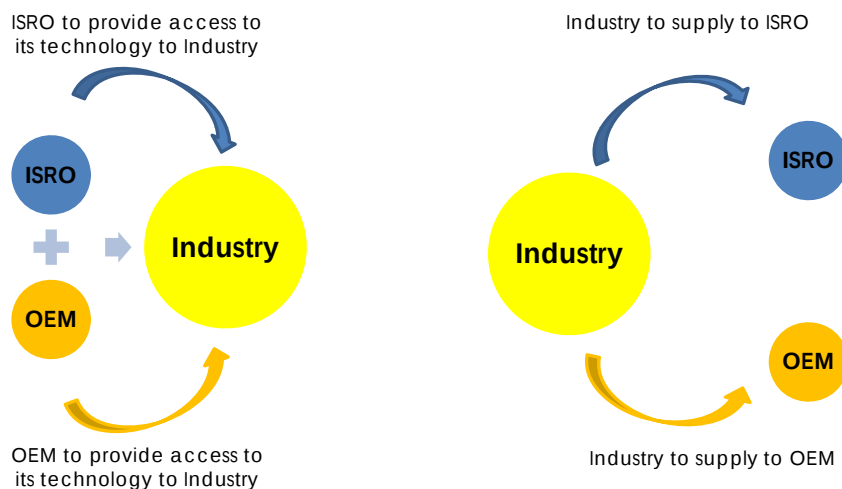


Turn key BTP and BTS mode



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Collaborative Partnership



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Combined Model Approach → Enhanced Engagement

- ISRO to ramp up its engagement model

Classical → Empowered → Collaborative approach

- At any given point in time, ISRO to have engagements with different Industries using different models.

Classical → Empowered → Collaborative approach
(many) (few) (very few)

- Such engagement model based effective cluster mapping by ISRO, will help Indian Industries to work with space standards across the globe and such an exercise will also spread the capacity within the Industry to replicate.



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Summary

- Almost two decades of space journey for Centum, with ISRO, has been interesting, challenging, continuous learning and also exciting.
- The lumpy and very low volume business challenges are being replaced with larger opportunities....this is a very positive trend.
- Industry need for ISRO is highest and Industry is also rightly poised to take on more.
- By taking some unconventional routes and engaging in different models with different Industries, one can create a WIN-WIN situation for both ISRO and the Industries.
- Centum is committed to be a part of this journey with ISRO.



TEAM WORK | TECHNOLOGY | TRUST



TEAM WORK | TECHNOLOGY | TRUST



Enabling Spacecraft Systems Realization through Industries

ESSRI 2017 14 Jul

Presentation by

C.D. SHRIDHARA
DIRECTOR

ANANTH TECHNOLOGIES LTD.
Hyderabad / Bangalore / Thiruvananthapuram

www.ananthtech.com

1



PRESENTATION OUTLINE

- ABOUT ATL
- CONTRIBUTION TO INDIAN SPACE PROGRAM
- MISSILE AND AIRCRAFT RELATED CONTRIBUTIONS
- ATL'S EXPERTISE
- NEW INFRASTRUCTURE FOR SATELLITE SYSTEMS
- SUMMARY

2



Ananth Technologies Ltd.

An EN/AS-9100C Aerospace Company



**ANANTH INFO PARK, NO. 39, HITEC CITY, PHASE-II,
MADHAPUR, HYDERABAD - 500 081.**

Ph: 040 – 6615 6615 Fax: +91 - 40 – 6615 6531, 6615 6652
E-mail: 1) subbarao@ananthtech.com 2) mail@ananthtech.com

Website: www.ananthtech.com

3



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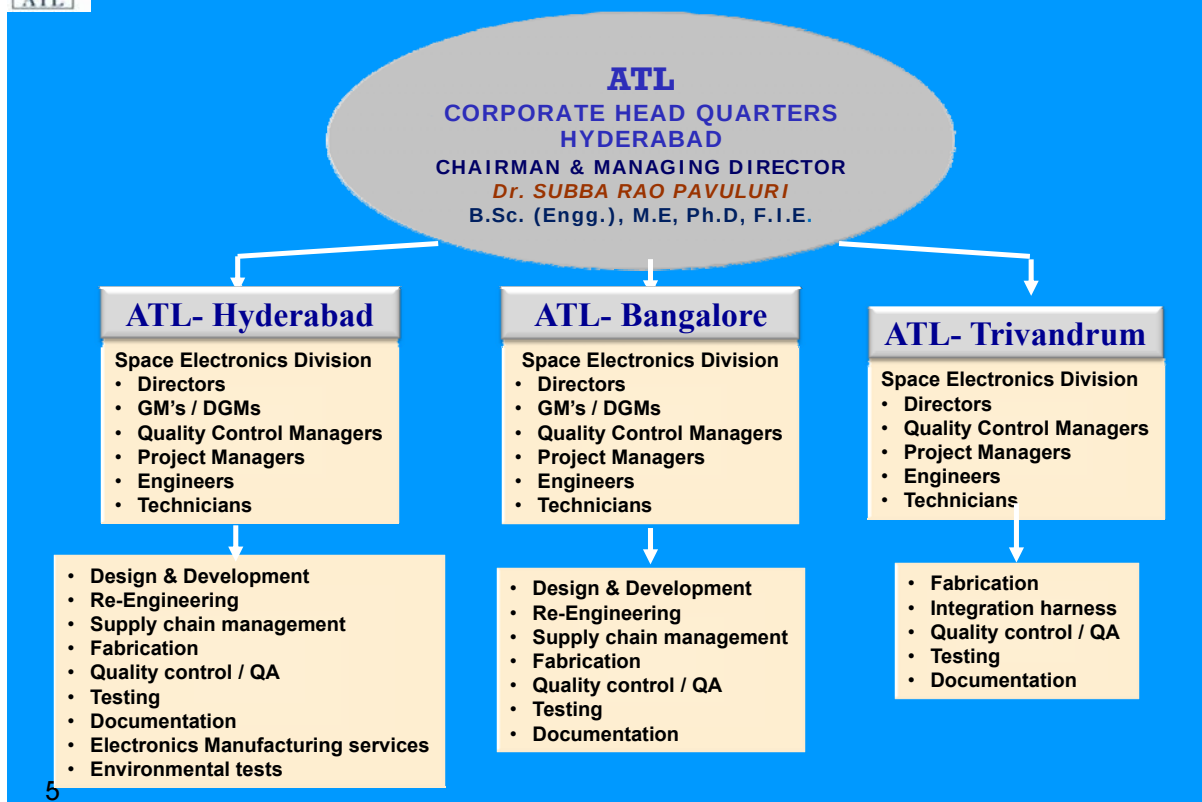
ATL INAUGURATION ADDRESS
By
Dr K KASTURIRANGAN then CHAIRMAN, ISRO



4



ORGANIZATION CHART



COMPANY PROFILE

- ATL is AS 9100C and ISO 9001:2008 certified company
- ATL was formed in the year 1992 with the objective of 'Indigenization of systems for Indian Space and Defence programs
- For the past 2.5 decades ATL has served Indian Aerospace industries (Department of Space & Defence) by executing various projects involving complex Digital, RF systems, Power systems & Integration
- During this process ATL has acquired the necessary expertise and experience in the design and development of state-of-the-art Digital, RF systems and sub-systems from HF to Microwave.
- ATL has class 100000 Clean Room for assembly and testing of PCBs, modules and sub-systems. ATL has Environmental Test facilities.



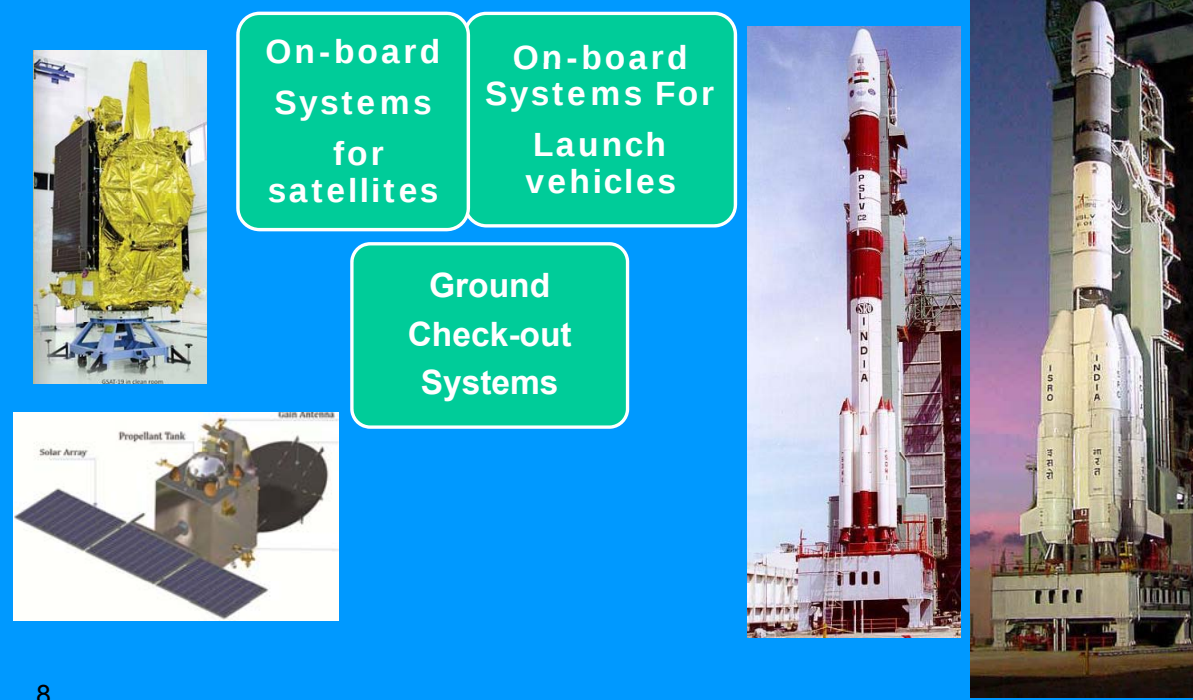
ATL Capability Overview



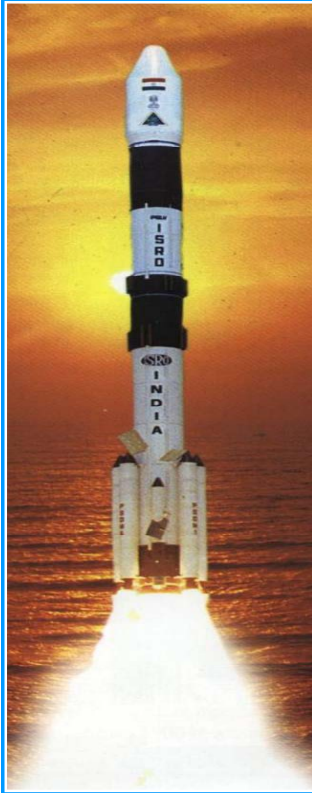
7



Contribution to Indian Space Programme



SUPPORT FOR LAUNCH VEHICLE



Integrated Control Unit	Positioning system
Data Processing Unit	Control electronics
Mini RU	Tx Transmitter
Mini CCU	Safety & Arming
Transponder	Power supply modules
Signal processor	RCS control
LNAs	Automated test equip.
DC-DC converters	Onboard processor
Launch sequencer	Servo control units
Navigation processor	Mission computer

LAUNCH VEHICLE SYSTEMS INTEGRATION

ATL has been contributing in the following activities beginning with board level fabrication to integration of systems

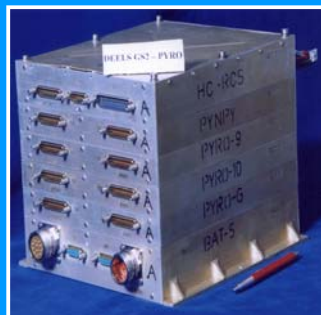
- Board level electrical fabrication
- Mechanical fabrication - module level
- Integration of subsystems – electrical & mechanical
- Integrated testing of subsystems
- Integration and testing of subsystems in Equipment Bay, propulsion and mechanisms
- Harness preparation and testing with ATEs
- Integration of systems at launch point – SHAR / ISRO



SUB SYSTEMS FOR INDIAN LAUNCH VEHICLES



BAT CARD (AMC)



GS2- PYRO



Data Processing Unit DPU



EB - PYRO



GS2 Control

11



SYSTEMS FOR PAYLOAD / SAC

Electronic power conditioners

TCXO's

Two way MSS terminal for vessel tracking using Gagan / NAVIC chip

C-band Receivers

Up / down converters

Messaging NAVIC receivers

Frequency generators

S-band Dual Driver Amp

Spacecraft Positioning System (SPS)

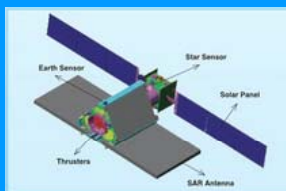
S band TR Modules

12



SPACECRAFT SUB-SYSTEMS

- Telemetry-Telecommand Systems (TMTC)
- Altitude and Orbit Control Electronics (AOCE)
- Core Power Packages
- Battery Simulators
- Bus Management Unit (BMU)
- Electronic Power Conditioners
- EMI Filters
- EED Packages
- Shunt Packages



- Regulators
- DC-DC Converters
- Distribution Packages
- Coarse Analog Sun Sensor
- 4 PI Steradian Sun Sensor
- Digital Sun Sensor (DSS)
- EOS M – Type Star Sensors
- HMC TEST JIGS
- Payload cards (SAC)

13



SUB SYSTEMS FOR INDIAN SPACE PROGRAMME



Attitude & Orbit Control Elec.



Sun Sensor



Star Sensor



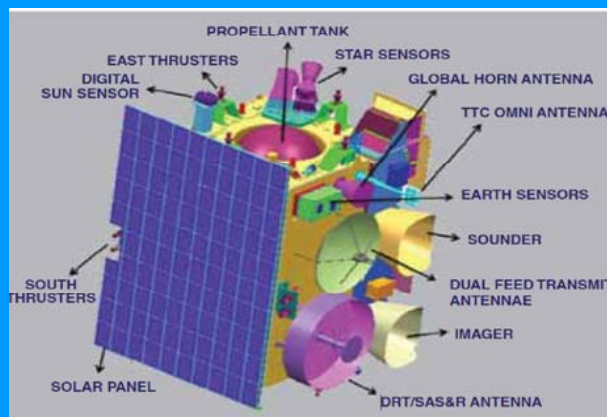
Power Distribution System



Core Power System



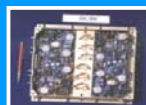
Pyro System



TTC System



Shunt Electronics



DC-DC Converters

14



SUB-SYSTEMS	Qty. Delivered	Qty. Under fabrication
Telemetry-Telecommand	23	2
Star Sensor	19	1
Attitude and Orbit Control Electronics (AOCE)	3	2
Bus Management Unit (BMU)	4	4
Core Power System	26	4
Electro Explosive Device (EED)	30	4
Shunt Package	18	4
Power Distribution Package	6	3
EMI Filter	834	66
DC-DC Converter	188	200
Sun Sensors (Digital, 4 pi steridian, Course analog)	70	

15



SPACE PRODUCTS PORTFOLIO

Satellite bus	Satellite payload	Launch vehicle
Telemetry, Telecommand systems	Electronic power conditioners	Mini PCM Telemetry system
Attitude, Orbit control electronics	TCXO's	Decoding Electronics for Sequencing
Bus Management Unit	C-band Receivers	Advanced Mission Computer
Core power system	Up / down converters	Dual power modules
EED systems	Frequency generators	Interface packages
Shunt system	S-band Dual Driver Amp	Advanced Signal Processing Unit
Power distribution System	Spacecraft Positioning System (SPS)	Mini Remote Units
DC-DC Converters	Micro Satellite	Mini Central Control Units
EMI Filters	TR Modules	Integrated Control Unit
Sun sensor system		Data Processing Units
Star sensor system		DC-DC converters
Automated test systems		HF DC-DC converters
Battery simulators		Automated test systems
HMC test jigs		

16



Sub systems for Indian Defense programme



Navigation
System



Onboard
Computer



IF Unit



RF SEEKER



PCM
Encoder



Signal
Conditioner



Flex Nozzle
Control



Servo
Controller



Actuator



TC Decoder



Pyro Relay
Unit



Telecommand
Receiver



Telemetry
Transmitters



Radio
Altimeter



Tracking
Transponder



Proximity
fuses

17



SUPPORT FOR AIR CRAFT PROGRAMME



Sl.No.	Product	Air Craft
1.	Strain Gauge Data Acquisition System (SGDAS)	LCA
2.	L-Band Telemetry Transmitter System	LCA
3.	S-Band Telemetry Transmitter	LCA
4.	Multi Channel Rotor Telemetry System	LCA
5.	AFCS system	SU-30
6.	RADAR assembly	SU-30
7.	Multi-output Power Supplies	MIG-29
8.	Stabilizers	MIG-29
9.	Amplifiers	MIG-29
10.	Frequency Synthesizers	MIG-29
11.	Non-contact load measurement system	ALH / LUH

18



Telemetry expertize

Salient features

- Bit rate : 1000 bps to 20 Mbps
- Output codes : All IRIG codes
- Frame size : Programmable up to 4096
- Major frame size : Programmable up to 256
- Commutation : Super, Normal, sub
- PMF : Programmable
- Format loading : Thro RS422
- Satellite telemetry : Compatible with CCSDS
- Frequency : L / S bands (programmable)
- Power output : 1W, 5W, 10W
- Modulation capability: PCM-FM, PSK, QPSK, OQPSK, FSK, etc.

19



Telemetry expertize

Types of inputs

- Strain : Quarter / half / full bridge with programmable excitation
- Pressure : Differential / absolute
- Vibration : ICP / IEPE / Charge
- Acoustic : Microphone
- Temperature : RTD or TC
- Electrical : With high isolation
- 1553 inputs : 1 / 2 or multi nodes
- ARINC input : 2 channels
- RS422 input : 4 channels
- Analog input : 256 channels
- Channel bandwidth: 40KHz
- Discrete events : 32 (typical)

20



Telemetry expertize

Applications

- Space communication – satellite telemetry
- Satellite launch vehicle telemetry
- Under water communications
- Telemetry for power turbine monitoring
- Telemetry for engine design validation & prognostics
- Telemetry for aircrafts / helicopters
- Telemetry for autonomous vehicles
- High 'g' telemetry for projectiles
- Telemetry for parachute based applications

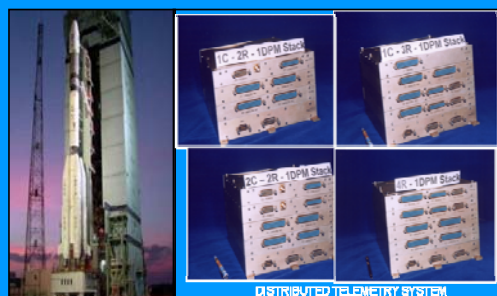
21



TELEMETRY EXPERTIZE



Satellite telemetry



Launch vehicle telemetry



Telemetry for defence programs

22



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TELEMETRY EXPERTIZE



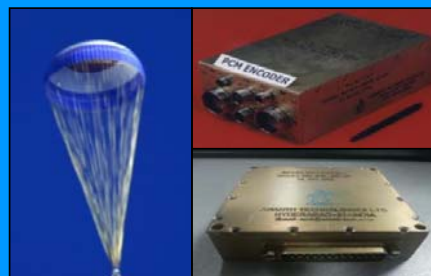
Engine telemetry



Aircraft telemetry



Telemetry for Helicopter sortie



Parachute telemetry

23



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Controls and Actuators

24



Control Systems expertize

Sallent features

- Device technology: BJT / MOSFET / IGBT
- Drive : High power drives upto 10KW
- Controller : Analog / Digital control
- Control Loops : Position / current



Control Systems expertize

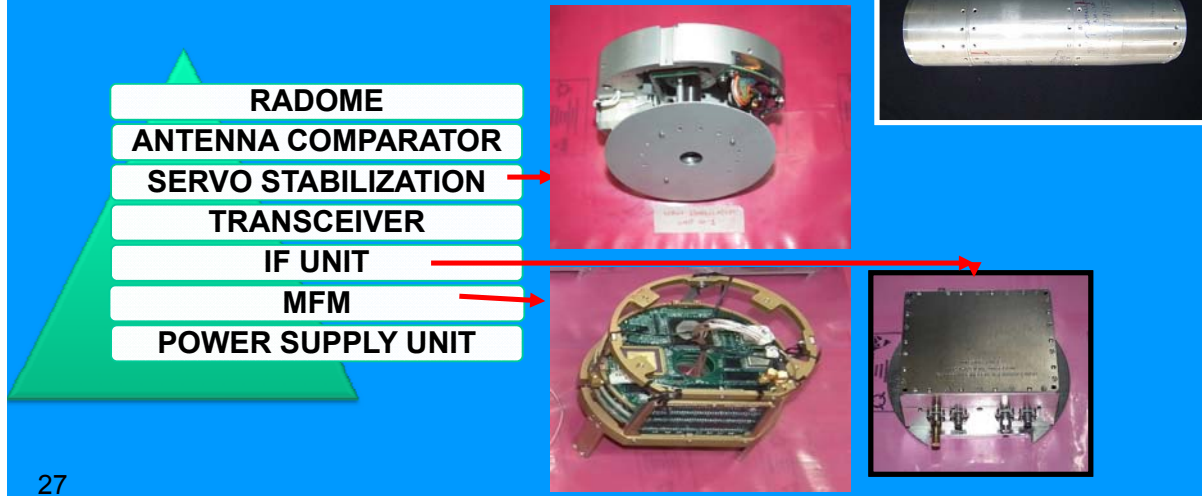
Applications

- Servo control for actuators
- Nozzle control systems for launch vehicles
- BLDC motors & drives
- Control system for Radars
- Stabilization platforms for gimbals
- Precision stabilization platforms for seekers

RF SEEKERS

The RF seekers are an active radar seeker in Ku & W-band to Detect, Acquire and Track the target in Angle, Velocity and Range. A two Axes Servo Stabilization constantly align the Antenna in the direction of the Target using tracking data.

BASIC BUILDING BLOCKS OF THE SEEKER



27

Servo Control Unit for AKASH

The Servo Control Unit (SCU) comprises of electronic amplifiers, filters and a power supply having DC/DC Converters. This unit mainly consists of six servo amplifiers to drive six actuator loads, in which four Actuators for Tail Control Panel and Two Actuators for Wing Control.



28

ELECTRO MECHANICAL ACTUATOR

A high power, lightweight linear Electromechanical Actuator essentially consists of a brush-less DC motor and a mechanical Ball screw with linear variable Potentiometer as a position sensor.

The product can withstand very high shock and vibration levels and generates a force of 500 Kgf with a bandwidth of 10 Hz.

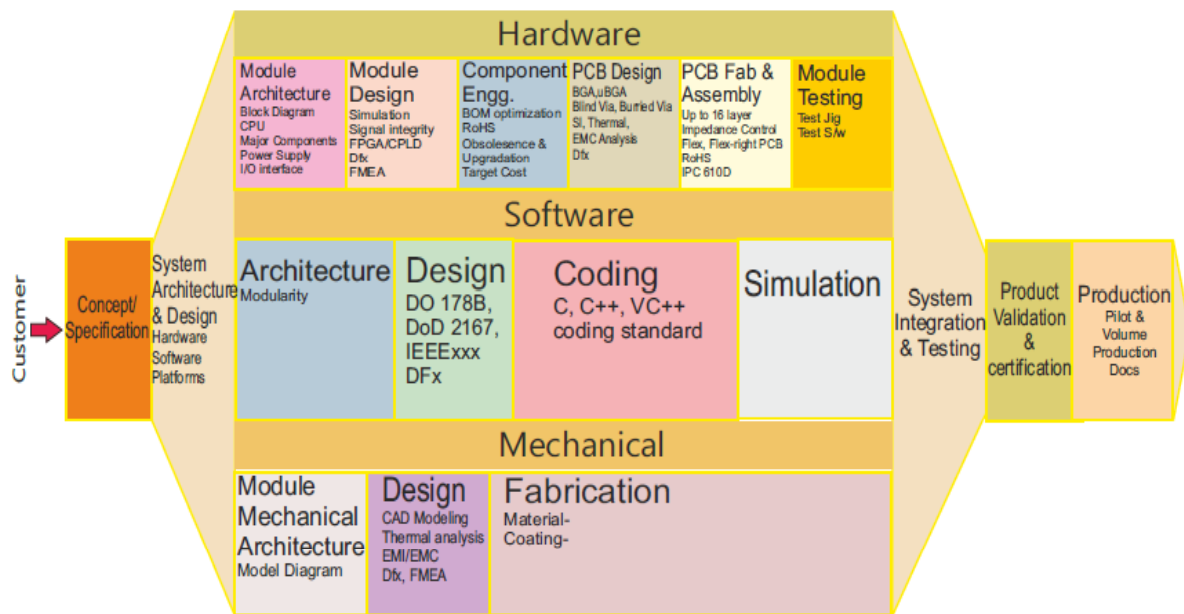
It is used for driving the control surface of a missile.



Digital & Embedded systems



Digital & Embedded systems



31



Digital & Embedded systems

Capabilities

- Processors & DSP : 8051, XAG (philips), PowerPC, XScale, ARM, RISC, ADSP, TIDSP
- Devices: Xilinx, ALTERA, Actel, Cycpress, Lattice
- HDL: VHDL, Verilog, RTL simulation & verification
- SoC NIOS-II based solutions
- Communication Interfaces : MIL 1553B, ARINC 429, ARINC 717, RS232, RS422, RS485, USB, Ethernet, I2C, SPI, CAN, GPIB, Mod-Bus, GSM, GPRS
- High speed digital design: LVDS, SDR, DDR, 60x, PCI-X, PCI- Express, GIGA-Ethernet, HDMI,

32



Digital & Embedded systems

Services

- Embedded Systems Solutions
- Board Design and analysis
- Embedded Software Development
- Automated Test Equipment development
- Product testing and qualification
- Manufacturing services

Products

- Onboard computers
- Digital receivers
- Radar signal processors
- RF based Foodsense systems
- Telemetry encoder with encryption
- EW simulators / Target simulators



On Board computers



On Board computers

Capabilities

- Processors : MPC 5200B / Intel486 / soft core in FPGA
- IO's : Analog / Digital IO's
- Interfaces : RS-422 / 1553 / CAN
- Typical memory
 - Application : 128 MB
 - Boot flash : 32 MB
 - SD RAM : 256 MB



On Board Processor

TECHNICAL SPECIFICATIONS

- Processor** : MPC 5200B
(Power PC with 256MHz core Frequency)
- Memory** : Application Flash 16MB (4MB x 32 bit)
Boot Flash 8MB (4MB x 16 bit)
SDRAM 128MB (32MB x 32 bit)
NVRAM 64KB (32 x 8 bit)
- FPGA** : Spartan
- Analog I/P** : 23 Single Ended with Bipolar inputs
(-10V to +10V) 16bit resolution
- Analog O/P** : 12 Analog Bipolar outputs (-10V to +10V)
12bit resolution
- DIPs** : 9
- DOPs** : 10





MIU Mark-III System

processor	: VirtexII Pro FPGA
Memory	: SRAM 256K x 16 Flash 256K x 16
1553 Channel	: 1 Dual redundant Bus channels
Serial channel	: 1 asynchronous RS422 channels
DOPs (Positive)	: 2
DOPs (Negative)	: 17
DIP High(32 Nos.)	: 24 channels +5V 8 channels +28V
Analog O/P	: 8 Nos.
Analog I/P	: 16 Nos. Single ended
Analog I/P	: 16 Nos. Differential



37



Inertial Measurement & Navigation Systems

38



Inertial Measurement & Navigation Systems

RLG BASED INS SYSTEM

CPU	: Intel 80486 DX2
Memory	: SRAM 512K x 32 Flash 512K x 32 NVRAM 32K x 16
1553 Channel	: 2 Dual redundant Bus channels
Serial channel	: 3 asynchronous RS422 channels
Gyro Bias Stability	: <0.1°/Hr
Gyro Dynamical Range	: $\pm 400^\circ/\text{sec}$
Random Walk	: <0.02°/Hr
Gyro Scale Factor Accuracy	: 20ppm
Acceleration Scale Factor Accuracy	: <200ppm
Acceleration Bias Stability	: <200 μg
Bandwidth	: 50Hz



39



Inertial Measurement & Navigation Systems

Trajectory monitoring system for LCA dropped bombs



Parameters monitored

Tri-axial acceleration

Yaw, Pitch & Roll rate

Compass

Pressure

Temperature

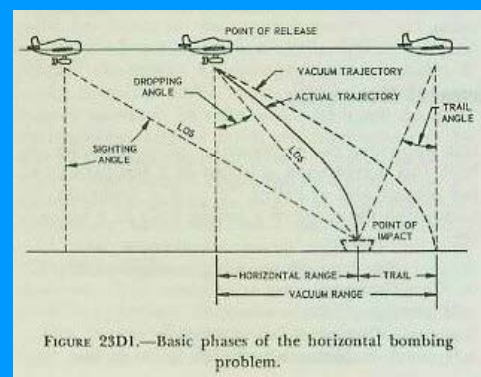


FIGURE 23D1.—Basic phases of the horizontal bombing problem.

40



RF and Microwave Capability

41



RF and Microwave

Products range

- Telemetry transmitters in UHF / L / S bands
- Telecommand Receivers
- RF seekers upto W-band
- Transmit – Receive modules
- Transponders
- Radio proximity fuzes
- Frequency converters
- Radio altimeters
- Power amplifiers
- Noise source for jammers
- EW simulators / Target simulators

42



RF and Microwave

Applications

- Airborne telemetry
- Underwater communication
- Tracking and control of air vehicles
- Proximity fuzes for artillery & ammunition
- Communication jammers
- EW systems
- Radar systems

43



RF and Microwave

Products



Altimeter



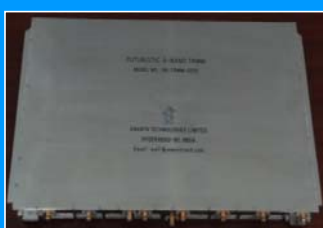
Command
Guidance Unit



Radio
Proximity Fuze



VLF power
amplifier



TR Modules



Transponder



RF Seeker

44



ANTENNA SYSTEMS

- **TELEMETRY ANTENNA SYSTEM**
- **FMCW RADIO ALTIMETER ANTENNA SYSTEM**
- **C-BAND MICROSTRIP CORPORATE FEED ARRAY ANTENNA**
- **TELECOMMAND Rx ANTENNA**
- **TELEMETRY Tx ANTENNA**
- **C&X – BAND HELICAL ANTENNA**
- **SLOTTED WAVEGUIDE ANTENNA**



ANTENNA SYSTEMS





Laser & Optical Systems

47



Laser & Optical Systems

Products range

- Digital, Analog & Steradian Sun Sensors
- Star tracker
- Ring Laser Gyros based Inertial Navigation Systems
- Explosive detection and chemical analysis systems
- Laser designator and Range finder
- Laser based Altimeters
- Laser Radar (LIDAR)
- Imaging LIDAR
- Optical, Laser and Holographic sights
- IR & Thermal Imaging

48



Laser & Optical Systems

Applications

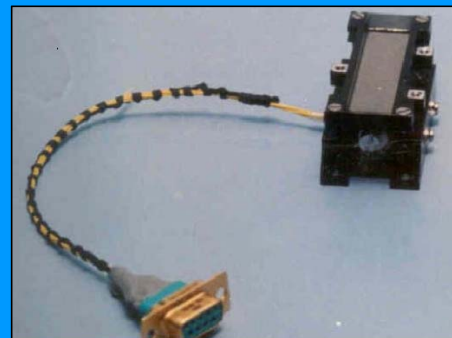
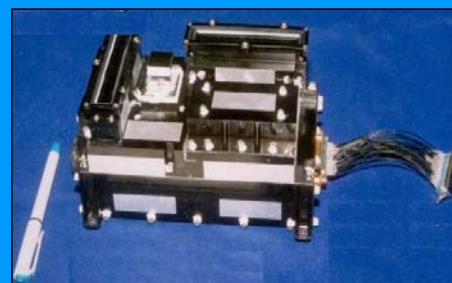
- Satellites stabilization
- Airborne navigation
- Security & scanning systems at airports
- UAV auto landing
- Border security / coast guard surveillance
- Night vision systems / gun sights for soldiers
- Driver's sighting system for tanks



Laser & Optical Systems



Star Sensor



Sun Sensors



Laser Designator



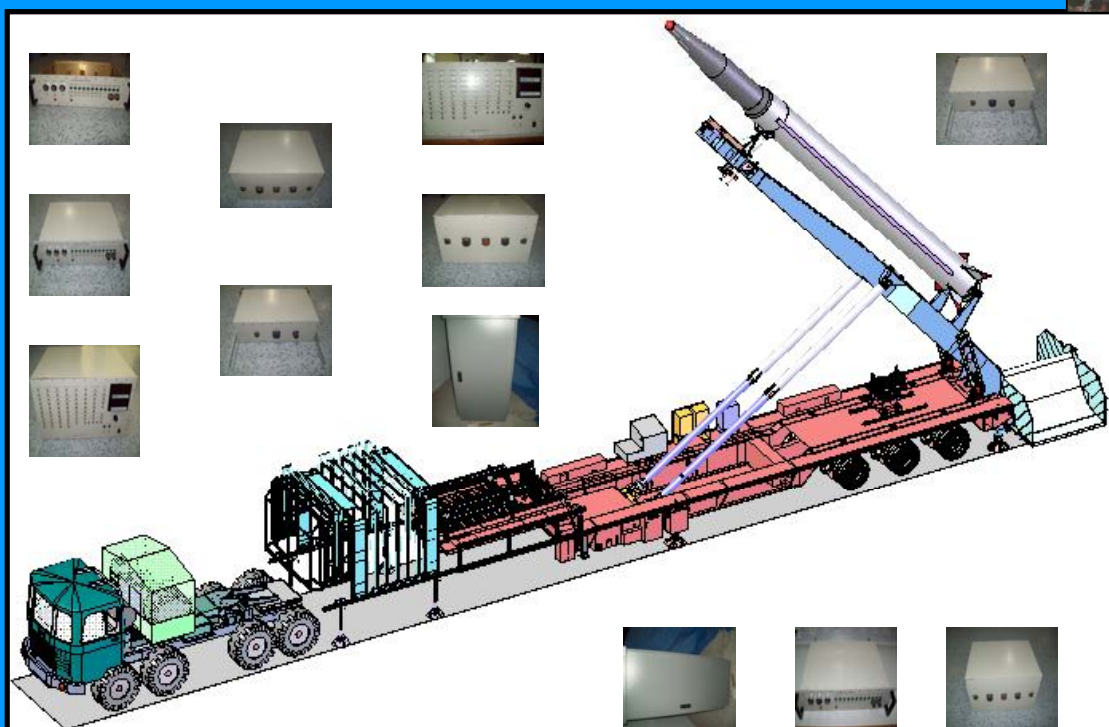
Integration & Ground Checkout

51



GROUND SYSTEMS:
MISSILE LAUNCHER:

Client: Missile System

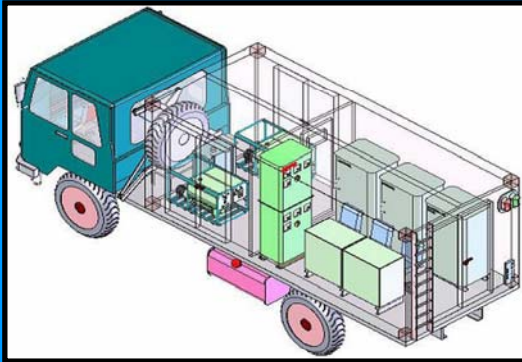


52



GROUND SYSTEMS:

LAUNCH CONTROL CENTRE (LCC) Client: Missile System



MECHANICAL ENGINEERING

- ◆ Design
- ◆ Modeling 2D, 3D
- ◆ Analysis (Structural, thermal etc.)
- ◆ Manufacturing
- ◆ Testing & Inspection

For Aerospace & Defence mechanical systems integrated with electronics, sensors, sights, mountings etc.





Familiarity with Requirements of Inspection Agencies

S No	Quality / Inspection Agency	Category of products
1	Systems Reliability Group (SRG)	Satellite products
2	Quality Assurance Division (QAD)	Launch vehicle products
3	Strategic Systems Quality Assurance Group (SSQAG)	Strategic systems' products
4	Missile System Quality Assurance Agency (MSQAA)	Missile systems – under production
5	Reliability & Quality Assurance (R&QA)	Missile systems – under development
6	Quality Control (QC-BDL)	Products for BDL
7	Centre for Military Airworthiness and Certification (CEMILAC) / Regional Centre for Military Airworthiness (RCMA)	Airborne systems – design approval
8	Chief Resident Inspector (CRI)	Airborne Systems – Under Production
9	Article Overseeing Team (AOT)	Naval systems

55

"No ATL products ever failed to meet mission life requirements"



LAB FACILITIES

56



ATL MANUFACTURING CAPABILITY

- ATL has Fully qualified Class 100000 Clean room with ESD protection for all manufacturing requirements
- Pick N Place and solder Reflow Machine
- Environmental Test Facility :
 - ❖ Environmental Test Chambers
 - ❖ Vibration Table, Bump M/c
- All Technicians are trained by ISAC, VSSC & SAC Training schools:
 - ❖ Soldering
 - ❖ Cable/Wire Harnesses
 - ❖ Crimping
 - ❖ Conformal Coating
 - ❖ Wire Wrap
 - ❖ Micro-sectioning of MLBs



“Fully Operational Space Systems Manufacturing Facility”

57



Automated Assembly Line



Cleanroom with ESD protection, all accessories



Stencil Printer



Solder paste height measuring system



Reflow machine



Pick & place machine

58



Ananth Technologies Ltd.

An EN/AS-9100C Aerospace Company

Manual Assembly Line



Fabrication Area



Inspection Area



Coil Winding Area



Mechanical Assembly Area

59



Ananth Technologies Ltd.

An EN/AS-9100C Aerospace Company

MIC Assembly Line



INSPECTION



MIC Assembly Facility

60



Testing Line



CARD LEVEL TESTING

61



Environmental Test Facilities



Humidity chamber



Vibration Shakers



Thermal chambers



Bump test machine



Acceleration / Centrifuge



Spin test machine

62

Facility Expansion Details

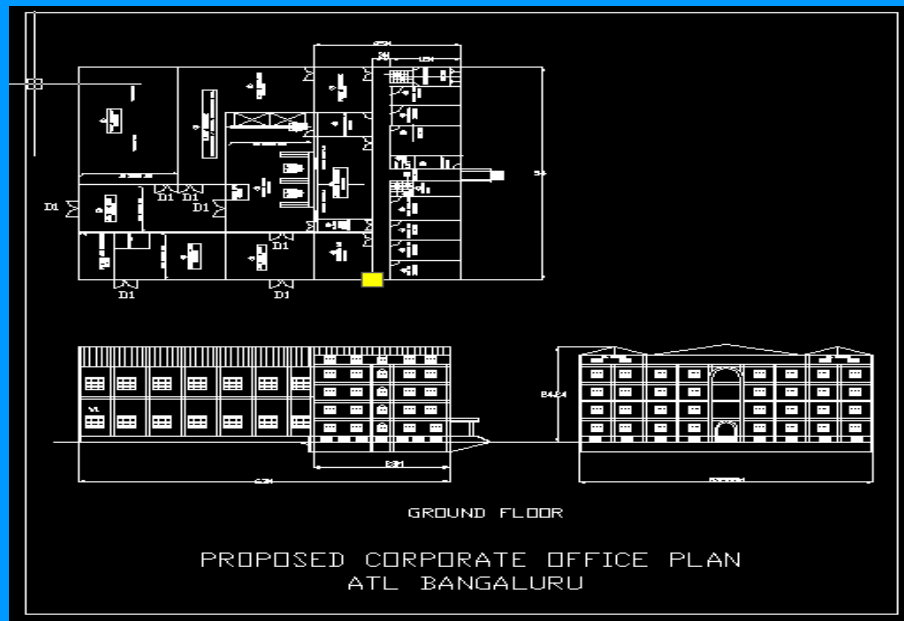
63

Space systems facility, Aerospace Park, Devanahalli, Bangalore



64

Space systems facility, Aerospace Park, Devanahalli, Bangalore



- ✓ Overall size. - 2400 Sq. m
- ✓ Clean Room – 360 Sq m.

65

Space systems facility, Aerospace Park, Devanahalli, Bangalore

ASSEMBLY INTEGRATION AND TEST FACILITY

Can cater for Satellites up to 2000 Kg. Class,

- Clean room of 1 lakh class - Complete assembly and integration of all satellite systems and conduct of integrated spacecraft tests.
- End-to-end capability to realise spacecrafts from entry of structure to exit of completely assembled and tested satellite.
- **Spacecraft level test facilities**
 - Ground check out facility for Integrated Spacecraft Testing (IST).
 - Physical measurements (CG, MI, PI)
 - Alignment systems
 - Zero 'G' facility for solar array integration to spacecraft & conduct of deployment tests
 - Vibration
 - Thermovac
 - Electrical and Mechanical Ground Support Equipment

66



Space systems facility, Aerospace Park, Devanahalli, Bangalore

SPACECRAFT SUB-SYSTEM LEVEL TEST FACILITIES

- *Harness facility - Design, Fabrication, Testing*
- *Sub-system level testing for Avionics systems*
- *Payload assembly/preparation & testing area*
- *Structure assembly & preparation area*
- *Propulsion systems preparation area*
- *Deployment mechanisms - Sub-system level assembly, test & characterization*
- *Thermal systems preparation area*
- *Vibration Shakers - 16 T, 2.5 T*
- *Thermo-vac chambers - 4m, 2m, 0.75m*
- *Hot & Cold Chambers*
- *Humidity Chambers*
- *Baking Ovens*



FABRICATION FACILITIES

- **MECHANICAL FABRICATION**
 - Co-ordinate Measuring Machine
 - Five axis CNC Turn mill center
 - CNC wire cut EDM
 - Surface grinding Machine
 - Vertical Milling Center
 - Drilling Machine
 - Profile projector
 - Micro height master
- **ELECTRICAL FABRICATION**



OTHER AREAS WHERE ATL CAN CONTRIBUTE TO ISAC, IN ENABLING SPACECRAFT SYSTEMS REALISATION

- Harness design, fabrication and testing.
- Components screening.
- Miniaturisation of electronic packages – joint activity
- Production of electromechanical drives like DGA and reflector Deployment & Pointing Mechanisms(DPM).
- Production of Solar arrays.
 - *Solar cell assembly on to substrates - bonding, curing, inspection and conduct of environmental tests on Solar panels.*
 - *Production of Mechanism sub-assemblies*
 - *Assembly of mechanism sub-assemblies to solar panel, Solar array assembly using Zero 'g, fixture,, Conduct of deployment tests.*
 - *Readiness of Solar array to integrate with S/C*

69



ADVANTAGE ATL

- **Management:** ATL is founded by Sr. Scientists from ISRO with complete awareness on realization space systems. Under their guidance ATL has been successful in enhancing their facilities from time to time to meet ISRO programs' requirements
- **Manpower:** ATL has 150+ ISRO certified manpower for production of high reliable systems for space needs
- **Facilities:** ATL has ISRO certified facilities in Hyderabad, Bangalore & Trivandrum. The work can be shared across the work centres to meet peak loads
- **Heritage:** From past 24 years ATL has been contributing to ISRO programs successfully.

70



SUMMARY

- ATL is already space-qualified
- ATL meets the stringent quality standards of ISAC's space systems
- ATL has excellent track-record of adhering to ISAC's project schedules with zero defect products
- ATL is fully geared to cater to all AIT activities for satellites.
- ATL has signed MOUs with foreign & Indian space companies which will enable procurement and hardware realisation more efficiently.
- New infrastructure coming up in Bangalore can take-up more end-to-end activities.
- **ATL is keen to play a bigger role in the forthcoming activities of Indian space program.**



AWARDS





AWARDS



'SAQR award for quality and reliability in aerospace products (2008)' from Dr. Prahlada, DS & CC R&D (SI), DRDO



ELCINA-DUN BRADSTREET Award for 2006-2007 for Research & Development, given by Union Minister for IT & Telecommunications, Govt. of India to Ananth Technologies Ltd.



Felicitations of Dr. Subba Rao Pavuluri, Managing Director, Ananth Technologies Ltd. (ATL) by Dr. Atre, Scientific Advisor to Defence Minister, Government of India



Dr. SUBBA RAO PAVULURI, MANAGING DIRECTOR, ATL Receiving the Award for "EXCELLENCE IN AEROSPACE INDIGENISATION" From Prof. Ramamurthy, Secretary - DST, Govt. of India



AWARDS



Dr. SUBBA RAO PAVULURI, MANAGING DIRECTOR, ATL Receiving the 6th IETE Corporate Award for "PERFORMANCE EXCELLENCE IN THE FIELD OF ELECTRONIC SYSTEMS & SOFTWARE"



Dr. Subba Rao Pavuluri receiving the National Award for Entrepreneurship on 28-8-2002 in New Delhi from Sri Jaswant Singh, Minister of Finance, GOI, Mrs Vasunphara Raje Scindia, Minister of State for Industries present.



Dr. Subba Rao Pavuluri, Managing Director, Ananth Technologies Ltd. (ATL) receiving the National Award for Excellence for the outstanding achievements in R & D in Electronics Embedded Systems on 07-10-2003 in New Delhi from Hon'ble Union Minister for Communications and Information Technology



THANKS



About Us

- Incorporated as a private limited Company in 1991
- Turned to public limited company in 1993.
- Today the company has grown to 1100 employees with an average annual turnover > Rs. 400 cr.
- AMPL is an ISO 9001:2008 and AS 9100:Revision C certified.
- Core strengths are in RF and Microwave and associated digital systems, sub-systems, components for Defence, Space & Aerospace, Missile and Meteorological markets

AMPL is into Design, Development and Manufacture of RF / Microwave sub-systems and components.

- ✓ Applications: Defence, Space, Telecom & Meteorology
- ✓ Frequency range: 30 MHz to 40 GHz

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3

World Class Infrastructure

One R&D &
Three Production Facilities



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4

Product Range



Manufacturer of high-end, critical RF and Microwave Components and Sub-systems

Defense	Space	Telecom	Other areas
✓ Radars ✓ Electronic Warfare Systems ✓ Missile Electronics ✓ Telemetry	✓ Flight Model & Ground based Application ✓ INSAT MSS Terminals ✓ Automatic Weather Stations (AWS)	✓ Antennas ✓ Filters ✓ Repeaters & Amplifiers	✓ MMIC Design, testing and packaging ✓ Contract Manufacturing ✓ Homeland Security

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5



Space Group

Design Development Fabrication & Screening of Sub-Systems Under One Roof



Built-up Area : 35,000 Sq. Ft
Status : Own

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6



Space Group

- Space Group started in 2004.
- Established Clean Room for an area 6000 sq.ft. with all the required facilities.
- RF Design using ADS & Microwave Office. Momentum/Axim software for EM simulation.
- Number of operators & Inspectors certified by ISRO.
- Established facilities for MIC & Soft Substrate Assemblies
- Qualified for Seam Sealing & Laser Welding.
- Number of Test setups working up to 40 GHz.

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CLEAN ROOM



CLEAN ROOM



7

Space Group

Established the following screening facilities:

1. Temperature Chambers
2. Burn-in Ovens
3. Vibration Systems
4. Thermovac Chambers
5. PIND Testers
6. Centrifuge Systems
7. Pressurization, Gross & Fine Leak Testers
8. EMI/EMC Testing up to 26.5 GHz for 416 C, E & F (NABL accredited)



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8

Facilities for Incoming Inspection



- High Magnification Microscope
- XRF for plating thickness measurements
- 1 Micron Accuracy profile projector
- Die shear and bond pull tester
- Sheet Resistivity tester
- Adhesion Tester
- Surface Roughness tester
- Op to Therm IR imaging for junction temperature measurement
- Micro-sectioning facility for via hole measurements
- Group A testing on PCB

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9



Space Group



Fabrication:

- AMPL is fabricating products against orders from design to T&E.
- Also fabricating products as per the customer's documents (with free issue of materials)along with RF Tuning & T&E.
- Wherever needed procurement of the components will be carried as per R&QA requirements.
- Fabrication of RF Modules on rate contract basis.

Up-Screening:

- Carrying out up-screening of RF Components for VSSC & SAC.
- Carrying out the T&E for Modules for VSSC.

Lithography:

- Getting qualified for patterning on Aluminum Substrates.
- Getting qualified for patterning on Soft Substrates (Duroid)

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10



Space Group

Fabrication Methodology

- Capability of Up-Screening the RF Components wherever S-Level Components are not available and also time constraints.
- AMPL has qualified all the processes required for the fabrication of RF Modules. Some of the process are also qualified at other Vendor's facility.

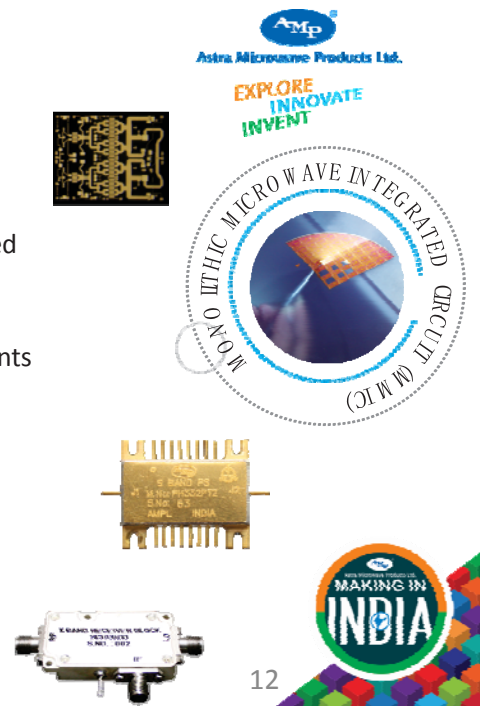


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11

Space Group

- AMPL has established the MMIC fabrication.
- Around 150 devices are designed and fabricated and are presently being used in most of the sub-systems being supplied to Defence.
- The devices include Control Components like Attenuators, Phase Shifters & Switches, Low Noise & Medium Power Amplifiers.
- Power Amplifiers up to 12 W using PHEMT Process.
- Details on the MMICs can be got from the web www.aeliussemi.com



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12

Capabilities★



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13

Capabilities

Research & Development

- ✓ Expertise in development of critical sub-systems for Radar, EW, Missile, Telemetry and Space
- ✓ In-house R&D
- ✓ PCB Design
- ✓ Mechanical design
- ✓ ATE design
- ✓ Test validations
- ✓ Environment qualification



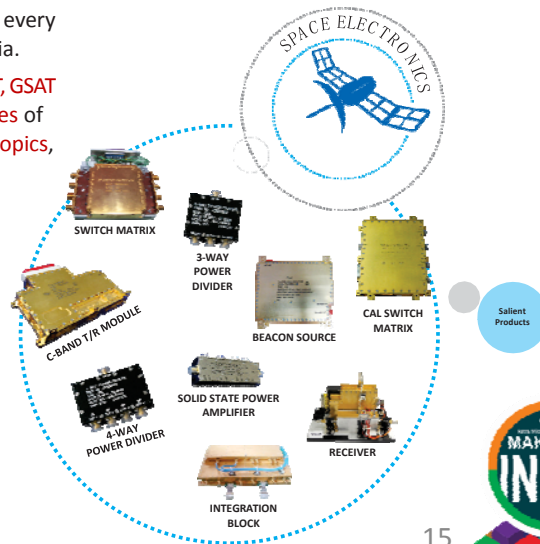
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14

Capabilities

Space Electronics

- ✓ Proud to be associated with every major satellite launch in India.
- ✓ Major contributions in **RISAT, GSAT** and **Remote Sensing Satellites** of ISRO, IRNS Missions, **Megatropics, Cartosat, Resourcesat, Saral.**



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15

Product Range★



AMP
Astra Microwave Products Ltd.
EXPLORE
INNOVATE
INVENT



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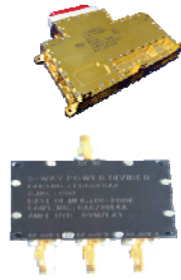
16

Product Range

Space Products

Flight model

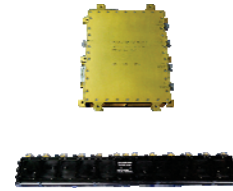
- ✓ Sub-systems for Radar Imaging Satellite
- ✓ Sub-systems for Geostationary Satellites
- ✓ Sub-systems for Remote Sensing Satellites



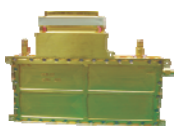
3-WAY POWER DIVIDER



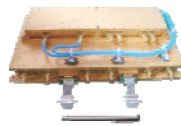
12-WAY POWER DIVIDER



RISAT Components



C-BAND T/R MODULE



INTEGRATION BLOCK



CAL SWITCH MATRIX



4-WAY POWER DIVIDER



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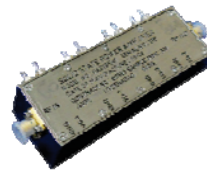
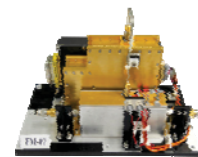
17

Product Range

Space Products

Flight model

- ✓ Sub-systems for Radar Imaging Satellite
- ✓ Sub-systems for Geostationary Satellites
- ✓ Sub-systems for Remote Sensing Satellites



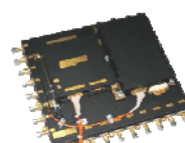
GSAT Components



SWITCH MATRIX



DOWN CONVERTOR



SWITCH MATRIX



BEACON SOURCE



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18

Product Range

Space Products

Ground based application

- ✓ Sub-systems for Multi-Object Tracking Radar (MOTR)
- ✓ Sub-systems for Mobile Multi-Object Tracking Radar (Mobile MOTR)



T/R MODULE



OUT DOOR UNIT



T/R MODULE - WIND PROFILER

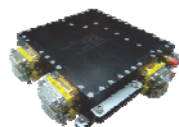


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19

Product Range

Transmitters



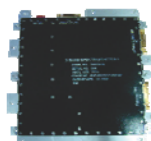
X-BAND QPSK TRANSMITTER



TELEMETRY TRANSMITTER



MOTR ANTENNA



S-BAND QPSK TRANSMITTER



TELECOMMAND RECEIVER



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20

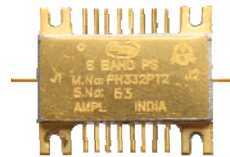
Product Range

MMIC Products

Astra is India's largest MMIC design house

Product Range:

- ✓ Core Chip
- ✓ Power Amplifiers
- ✓ Ultra Low Noise Amplifiers
- ✓ Phase Shifters
- ✓ Broadband Digital Attenuators
- ✓ High isolation switches
- ✓ Wide band amplifiers
- ✓ Gain equalizers
- ✓ Mixers



AMP
Astra Microwave Products Ltd.

EXPLORE
INNOVATE
INVENT



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21

Quality Standards★



AMP
Astra Microwave Products Ltd.

EXPLORE
INNOVATE
INVENT



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22

Quality Standards

Quality Procedures

- Inward Inspection
- In-process Inspection
- Final Inspection
- Astra meticulously follows PAX 300 & 305 guidelines for Inspection.
- Astra follows MIL883 C for Testing & Screening.



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23

Certifications



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24

AMPL Requests ISRO



1) Business Continuity:

- AMPL has been working in space for over 2 decades and have developed an eco-system and infrastructure to handle a certain amount of load
- Having invested in the above we wish to let ISRO know that we do not have sufficient and continuous load to cater to the expertise and infrastructure built.
- We suggest ISRO to identify industry for their domains of work expertise and
- Assure respective industry continual work load in the form of MoU,
- This encourage the industry to invest further and improve on the facilities, manpower etc.
- We suggest ISRO to nurture a healthy competition.

2) AMPL is coming up with our Bangalore Unit with an area of 1,00,000 Sq. Ft with necessary clean rooms and other infrastructure.

3) AMPL-Bangalore will also house Near Filed Test Range(NFTR/PNFM) facility for radar system calibration.

4) AMPL-Bangalore will be ready to offer its facility for Payload/System Integration and is willing to invest in other infrastructure where ever necessary.

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25



Thank you



Email: info@astramwp.com
www.astramwp.com

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26



STANDARD AVIONICS PRODUCTION HARDWARES

	AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE		
	SEG-TED-DOC-01	Revision-00	Issue Date :14-07-17
	AOCE-V1		

PROJECT	IRNSS SERIES	PACKAGE CODE	ACE-10 & 20
MODEL	FLIGHT	PKG. DIMENSIONS (mm)	270 x 300 x165

PRODUCT DESCRIPTION:

AOCE is MAR31750 processor based system where all the logics/interfaces shall be realized using ASICs. The AOCE is configured as two systems main & redundant which are in hot redundant and housed in separate mechanical packages. The system is designed in a motherboard - daughter board configuration. The logics and functional requirements of the mission have been distributed among the different cards.



AOCE V1 PACKAGE

1. ELECTRICAL & INTERFACE SPECIFICATIONS:

I/P VOLATGE (V)	MIN	26
	MAX	42
Interfaces (Conventional & Mil-Std- 1553B)	Thrusters	16 no.s
	Magnetic Torquers	2 no.s
	Sensors	CASS (8 heads) , SPSS (4 no.s), Star Sensors (2 no.s), DTG (3 no.s)
	Wheels	3 no.s
	LAM	1 no.s
	SADA	4 no.s
	Telecommand	ON/OFF : 5V,64ms PULSE 16 bit Data command
CPU	Honeywell Processor (HX-1750)	
Package Power	App. 10W	
TELECOMMAND	ON/OFF : 5V, 64ms PULSE 16 Bit Data Command	
Weight	6.6kg	

**AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE****SEG-TED-DOC-01****Revision-00****Issue Date :14-07-17****AOCE-V1****2. PCB DETAILS**

CARD	PCB CODE	DIMENSION(mm)	DESCRIPTION
A	OBC 10-5-07	228.6 x 203.2	CPU card
B	ACE 10-0-05	228.6 x 203.2	Data Acquisition card
C	OBC 10-1-14	228.6 x 203.2	Thruster Driver card
D	OBC 10-2-11	228.6 x 203.2	MTC LAM card
E	ACE-10-0-02	228.6 x 203.2	DC/DC card
F	ACE-MB-10-0-01	228.6 x 203.2	Mother Board



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

DC_DC_X-BAND_TX_TYPE

PROJECT	HYSIS	PACKAGE CODE	XBC-10
MODEL	FM	Package Dimensions (mm)	157X147X47.5

PRODUCT DESCRIPTION:

This is a Low power, highly efficient, isolated, 6 output DC-DC converter based on Forward topology. It is highly reliable with low component count. Performance of this converter is very stable even at extreme temperatures (-40 to +65°C). It can be used up to a power requirement of 5W-30W with minimal tuning. Since it is a low noise, small size deck mountable DC- DC converter, it finds application in X/S band RF powering applications in LEO/GEO spacecraft. The load and line transients are Less than 5% and the line and load regulations are less than 2% of rated output voltages. *It can also be stacked with other RF subsystems or with other DC-DC converters, if needed.*



1. ELECTRICAL SPECIFICATIONS:

I/P VOLATGE	MIN	26		
	MAX	42		
TOPOLOGY	NPW36-3-23A:	Forward		
	NPW36-3-23B:	Forward		
SWITCHIONG FEQUENCY	NPW36-3-23A:	110 KHz +- 10 %		
	NPW36-3-23B:	110 KHz +- 10 %		
HKB VOLTAGE	NPW36-3-23A:	13 V, 30 mA		
	NPW36-3-23B:	13 V, 30 mA		
EFFICIENCY	TYP >70 %			
OUTPUT POWER	NOMINAL	4.75 W		
	PEAK	NA		
CURRENT LIMIT THRESHOLD	NPW36-3-23A:	150% to 200% OF INPUT CUR.		
	NPW36-3-23B:	150% to 200% OF INPUT CUR.		
TELEMETRY	O/P VOLTAGE TM (M&R)	4 TO 5V		
TELECOMMAND	ON/OFF : 5V 64ms PULSE			
OUTPUTS	1	2	3	
VOLTAGE (V)	-5(-5V LINE)	+10(HKB 2 LINE)	+5.2(+15V LINE)	

ISAC Quality Policy: Committed to Total Quality and Zero Defect in Space Systems & Services



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

DC_DC_X-BAND_TX_TYPE

MIN. CURRENT	(mA)				
NOMINAL CURRENT (100%)	(mA)	100	165	500	
MAX. CURRENT	(mA)				
PEAK CURRENT	(mA)				
PEAK CURRENT DURATION	(ms)				
SETTABILITY(%)		+/-3	+/-3	+/-3	
LINE REGULATION	(%)	+/-3	+/-3	+/-3	
LOAD REGULATION	(%)	+/-3	+/-3	+/-3	
TURN ON (RISE TIME)	(ms)	<2	<5	<2	
TURN OFF (FALL TIME)	(ms)	<10	<20	<10	
RIPPLE (Pk-Pk)	(mV)	50	50	50	
SPIKE	(mV)	100			
DELAY(TURNON)		BETWEEN		BETWEEN	
		NA		NA	
DELAY(TURNOFF)		BETWEEN		BETWEEN	
		NA		NA	
Weight		0.563kg			
NOTE:					
1	RIPPLE AND SPIKE SHOULD ME MEASURED AT THE LOAD END ACROSS A 0.1Uf CAPACITOR WITH A 1X CRO PROBE WITH AS SHORT LEAD AS POSSIBLE.				
2	HARNESS LENGTH SHOULD BE 2 METERS.				
3	THE OUTPUT VOLATGE SHOULD BE MEASURED AT LOAD END.				
4	ALL OVERSHOOT AND UNDERSHOOT SHOULD BE within 15% OF NOMINAL O/p VOLTAGE for line transients. (26 to 42 and vice versa) ALL OVERSHOOT AND UNDERSHOOT SHOULD BE within 15% OF NOMINAL O/p VOLTAGE for Load transients (100 to 70% and vice versa)				
5	RISE TIME AND FALL TIME SHOULD BE WITHIN +/- 10% OF SPECIFIED.				
	ANY OTHER REQUIREMENTS / SPECIFICATIONS				



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

DC_DC_X-BAND_TX_TYPE

2. PCB DETAILS

CARD	PCB CODE	DIMENSION(mm)	DESCRIPTION
A	NPW36-3-23A:	#71x95x1.6	Forward
B	NPW36-3-23B:	#71x95x1.6	Forward

	AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE		
	SEG-TED-DOC-01	Revision-00	Issue Date :14-07-17
	DC_DC_ S BAND_TX_TYPE		

PROJECT	MICROSAT	PACKAGE CODE	SMT-15W-STC
MODEL	FLIGHT	PACKAGE DIMENSIONS (MM)	#78x82x30

PRODUCT DESCRIPTION:

This is a Low power, highly efficient, isolated, 2 output DC-DC converter based on Flyback topology. It is highly reliable with low component count. Performance of this converter is very stable even at extreme temperatures (-40 to +65°C). It is tunable and can be used up to a power requirement of 15W with minimal tuning. Since it is a low noise, small size DC- DC converter, it finds application in RF/TMTC and control electronics application in LEO/GEO spacecraft. The load and line transient are Less than 5% and the line and load regulations are less than 2% of rated output voltages.



1. ELECTRICAL SPECIFICATIONS:

I/P VOLATGE	MIN	26		
	MAX	42		
TOPOLOGY	SD15T101	FLYBACK		
SWITCHIONG FEQUENCY	SD15T101	170-190KHz		
HKB VOLTAGE	SD15T101	-		
EFFICIENCY	60 % (for lout =100%rated)			
OUTPUT POWER	4.2W			
Operating Temperature	-40 to +65°C			
CURRENT LIMIT THRESHOLD	SD15T101	-		
TELEMETRY	O/P VOLTAGE (VTM1)	0 TO 5V		
TELECOMMAND	ON/OFF : NONE			
OUTPUTS	1	2	3	
VOLTAGE (V)	+15 (15V LINE)	-15 (-15V LINE)		
MIN. CURRENT (mA)	0.2A	0.03A		
NOMINAL CURRENT (100%)				

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	AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE		
	SEG-TED-DOC-01	Revision-00	Issue Date :14-07-17
	DC_DC_ S BAND_TX_TYPE		

(mA)				
MAX. CURRENT (mA)				
PEAK. CURRENT (mA)				
PEAK CURRENT DURATION (ms) If applicable				
Over CURRENT LIMIT(% of Full load rated current)	130-300%			
Input current @ No Load	60mA			
Inrush Current	7A(for <1ms)			
SETTABILITY(%)	≤3%			
LINE REGULATION (%)	≤±1%	≤±2%	≤±2%	
LOAD REGULATION (%)	≤±1%	≤±3%	≤±3%	
CROSS REGULATION (%)	≤±1%	≤±3%	≤±3%	
LINE TRANSIENT (Iout=100% rated)	0.1V	1.25V	1.25V	
LINE TRANSIENT Recovery time (Iout=100% rated)	5ms	5ms	5ms	
TURN ON(RISE TIME) @ 100% load (ms)	5ms			
TURN OFF(FALL TIME)(ms)				
Over Current Protection Over Voltage Protectin	Pulse by Pulse & Hiccup			
Loop Entry	<24V			
RIPPLE (Pk-Pk) (mV)	30mV			
SPIKE (mV)				
Isolation	100MΩ			
DELAY(TURNON) if applicable				
DELAY(TURNOFF) if applicable				
Weight	0.244kg			
NOTE:				
1	The L/O is designed to cater to 3 voltage ranges Range1: 14-25V; Range2:22-45v; Range 3: 42-42v			
2	HARNESS LENGTH SHOULD BE <u> </u>			

	AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE		
	SEG-TED-DOC-01	Revision-00	Issue Date :14-07-17
	DC_DC_ S BAND_TX_TYPE		

3	THE OUTPUT VOLATGE SHOULD BE MEASURED AT <u> </u>
4	The o/p voltages are settable as per user requirements ±15v Line can be turned from ±5 to ±15V;the +5V Line can be turned from 3.3V to +8V with LDO.
5	Max Load on ±15V Line is 500mA; +5V Line is 1.9A. The total o/p Power should not exceed 15W at any load conditions.
6	Line regulation is as per specifications from min input voltage to max. Input Voltae in that particular range of input voltage as specified in note1:
7	User specified load is considered as nominal Load. Load regulation is assured from 70% to 100% of specified Load.
8	Load on the output under test is varied from 100% to 70% while remaining outputs are at 100%.
9.	Turn on rise time from 10% to 90% of final value
10.	The HKB Voltage is sensed for under voltage and over voltage of converter. Under these conditions the converter enters Hiccup mode. The over voltage of HKB is set around 17V.

2. PCB DETAILS

CARD	PCB CODE	DIMENSION(mm)	DESCRIPTION
A	SD15T101	#78*74	DC/DC



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

DC_DC_ C-BAND_TT&C _TYPE

PROJECT	IRNSS SERIES	PACKAGE CODE	R1NCM1140/111
MODEL	FLIGHT	PKG. DIMENSIONS (mm)	152x99x47.5

PRODUCT DESCRIPTION:

This is a medium power, very efficient, Isolated, 3 output DC-DC converter based on forward topology. It is highly stable, low noise converter which can be tuned to provide 4-20W of output Power. The load and line transient are better than 5% of output voltages. It can provide a power up and Power down sequencing Of 10 to 30 msec and can be tuned depends on load conditions. The line and Load regulation is excellent.



TT&C TYPE 20W DC-DC CONVERTER

1. TECHNICAL SPECIFICATIONS:

I/P VOLATGE	MIN	26		
	MAX	43		
TOPOLOGY	NPW36-3-23:	Forward		
	NPW36-2-24:	Forward		
SWITCHIONG FEQUENCY	NPW36-3-23:	110 KHz +- 10 %		
	NPW36-2-24:	90 KHz +- 10 %		
HKB VOLTAGE	NPW36-3-23:	12.5 V, 30 mA		
	NPW36-2-24:	12 V, 30 mA		
EFFICIENCY	TYP > 70 %			
OUTPUT POWER	NOMINAL	4W(Low Power), 15.8 W(High Power)		
	PEAK	4.4W(Low Power), 18 W(High Power)		
CURRENT LIMIT THRESHOLD	NPW36-3-23A:	150% to 200% OF INPUT CUR.		
	NPW36-3-23B:	150% to 200% OF INPUT CUR.		
TELEMETRY	O/P VOLTAGE TM (M&R)	4 TO 5V		
TELECOMMAND	ON/OFF : 5V 64ms PULSE			
OUTPUTS	1	2	3	
VOLTAGE (V)	-5	+15	+8 (LOW PWR)	+8 (HIGH PWR)
MIN. CURRENT (mA)	25	100	200	
NOMINAL CURRENT (100%) (mA)	30	110	250	
MAX. CURRENT (mA)	35	120	300	
PEAK. CURRENT (mA)	NA			
PEAK CURRENT DURATION (ms) If applicable	NA			
SETTABILITY(%)	+/-3	+/-3	+/-3	

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SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

DC_DC_ C-BAND_TT&C _TYPE

LINE REGULATION (%)	+/-3	+/-3	+/-3
LOAD REGULATION (%)	+/-3	+/-3	+/-3
TURN ON(RISE TIME)(ms)	>2ms	>2ms	2ms
TURN OFF(FALL TIME)(ms)			
RIPPLE (Pk-Pk) (mV)	40	40	40
SPIKE (mV)			
DELAY(TURN-ON) if applicable	BETWEEN -5V and +15V		BETWEEN -5V and +8V
	≥ 10ms		≥ 10ms
DELAY(TURN-OFF) if applicable	BETWEEN -5V and +8V		BETWEEN -5V and +8V
	Min 5ms(50% of +15V to 50% of +5V)		Min 5ms(50% of +8V to 50% of -5V)
Weight	0.616kg		
NOTE:			
1	RIPPLE AND SPIKE SHOULD ME MEASURED AT THE LOAD END ACROSS A 0.1uF CAPACITOR WITH A 1X CRO PROBE WITH AS SHORT LEAD AS POSSIBLE.		
2	HARNESS LENGTH SHOULD BE 0.5 METERS.		
3	THE OUTPUT VOLATGE SHOULD BE MEASURED AT CONVERTER END with non-current carrying wires.		
4	ALL OVERSHOOT AND UNDERSHOOT SHOULD BE within 15% OF NOMINAL O/p VOLTAGE for line transients. (26 to 42 and vice versa) ALL OVERSHOOT AND UNDERSHOOT SHOULD BE within 15% OF NOMINAL O/p VOLTAGE for Load transients (100 to 70% and vice versa)		
	ANY OTHER REQUIREMENTS / SPECIFICATIONS		

2. PCB DETAILS

CARD	PCB CODE	DIMENSION(mm)	DESCRIPTION
A	NPW36-3-23:	85.75*69.98*2	Forward
B	NPW36-2-24:	100.9*74.3*2	Forward

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AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

DC_DC_TC_INTERNAL_TYPE

PROJECT	GSAT-19	PACKAGE CODE	SMT-50W-V1-TC1
MODEL	FLIGHT	PACKAGE DIMENSIONS (MM)	#106x97x41

PRODUCT DESCRIPTION:

This is a high power, highly efficient, isolated, 2 output DC-DC converter based on forward topology. It is highly reliable with low component count. Performance of this converter is very stable even at extreme temperatures (-40 to +65°C). It can be used up to a power requirement up to 50W with minimal tuning. Since it is a low noise, small size DC-DC converter, it finds application in RF/TMTC and control electronics application in LEO/GEO spacecraft. The load and line transients are less than 5% and the line and load regulations are less than 2% of rated output voltages.



1. ELECTRICAL SPECIFICATIONS:

I/P VOLATGE	MIN	42V	
	MAX	72.5V	
TOPOLOGY	SD50F301	Current Fed Push Pull Topology	
	SD50F202		
SWITCHIONG FEQUENCY	SD50F301	250KHz to 270KHz	
	SD50F202		
HKB VOLTAGE	SD50F301		
	SD50F202		
EFFICIENCY	TYP > 70 %		
Overvoltage limit point (Experessed as a percentage of Full rated output voltage)	≥110%		
RB UVLO	Turn ON @40V(± 1V) Turn OFF @ 36V(± 1V)		
OUTPUT POWER	NOMINAL		
	PEAK		
CURRENT LIMIT THRESHOLD	SD50F301		
	SD50F202		
TELEMETRY	O/P VOLTAGE (VTM1 & VTM2)	0 TO 5V	
TELECOMMAND	ON/OFF :		
OUTPUTS	1	2	3

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AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

DC_DC_TC_INTERNAL_TYPE

VOLTAGE (V)	6.5V	+30V		
MIN. CURRENT (mA)	0.4A	NL		
NOMINAL CURRENT (100%) (mA)	0.4A	30mA		
MAX. CURRENT (mA)				
PEAK. CURRENT (mA)	3A	1.5A		
CURRENT LIMIT THRESHOLD	4A ± 0.5A (O/P current)	1.5A ± 0.5A(Raw bus I/P Current)		
SETTABILITY(%)	≤3%			
LINE REGULATION (%)	≤1%			
LOAD REGULATION (%)	≤3%			
TURN ON(RISE TIME)(ms)				
TURN OFF(FALL TIME)(ms)	< 6A(2ms ± 1.5 ms duration)			
RIPPLE (Pk-Pk) (mV)	≤50		≤150	
SPIKE (mV)				
DELAY(TURNON) if applicable	BETWEEN		BETWEEN	
DELAY(TURNOFF) if applicable	BETWEEN		BETWEEN	
Weight	0.530kg			

NOTE:

1.	RIPPLE AND SPIKE SHOULD ME MEASURED AT THE LOAD END ACROSS A 0.1Uf CAPACITOR WITH A 1X CRO PROBE WITH AS SHORT LEAD AS POSSIBLE.
2.	HARNESS LENGTH SHOULD BE __ METERS __ AWG.
3.	THE OUTPUT VOLATGE SHOULD BE MEASURED AT _____.
4.	ALL OVERSHOOT AND UNDERSHOOT SHOULD BE within 15% OF NOMINAL O/p VOLTAGE for line transients. (26 to 42 and vice versa) ALL OVERSHOOT AND UNDERSHOOT SHOULD BE within 15% OF NOMINAL O/p VOLTAGE for Load transients (100 to 70% and vice versa)
5.	RISE TIME AND FALL TIME SHOULD BE WITHIN +/- 10% OF SPECIFIED.
6.	During overload or short circuit condition converter enters in to Hiccup.
7.	The over voltage protection is provided under the circumstances of control loop failure of the circuit. The converter enters into Hiccup mode under this condition. Normally the over voltage limit set to nearly 110% of HKB voltage.
8.	For line change of 67V to 72.5V

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**AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE****SEG-TED-DOC-01****Revision-00****Issue Date :14-07-17****DC_DC_TC_INTERNAL_TYPE**

9.	For load change from 100% to Peak load
10.	For load change from Peak load to 70% (of Peak load)
11.	For Raw bus voltage of 70V
	ANY OTHER REQUIREMENTS / SPECIFICATIONS

2. PCB DETAILS

CARD	PCB CODE	DIMENSION(mm)	DESCRIPTION
A	SD50F301	60.5*92	Power card
B	SD50F202	77*92	Control Card



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

DC_DC_SPS_TYPE

PRODUCT DESCRIPTION:

This is a high power, highly efficient, isolated, 2 output DC-DC converter based on Forward topology. It is highly reliable with low component count. Performance of this converter is very stable even at extreme temperatures (-40 to +65°C). It can be used up to a power requirement of 60W with minimal tuning. Since it is a low noise, small size DC- DC converter, it finds application in RF/TMTC and control Electronics application in LEO/GEO spacecraft. The load and line transients are Less than 5% and the line and load regulations are less than 2% of rated output voltages.



1. ELECTRICAL SPECIFICATIONS:

I/P VOLATGE	MIN	26V		
	MAX	42V		
TOPOLOGY	NPW36-3-23	Forward		
	NPW36-0-60	Forward		
SWITCHIONG FEQUENCY	NPW36-3-23	110 KHz ± 10 %		
	NPW36-0-60	90 KHz ± 10 %		
HKB VOLTAGE	NPW36-3-23	13 V, 30 mA		
	NPW36-0-60	10 V, 30 mA		
EFFICIENCY	TYP > 65 %			
OUTPUT POWER	NOMINAL	6 W		
	PEAK	13 W		
CURRENT LIMIT THRESHOLD	NPW36-3-23	150% to 200% OF INPUT CUR.		
	NPW36-0-60	>120% OF INPUT CUR.		
TELEMETRY	O/P VOLTAGE TM (M&R)	4 TO 5V		
TELECOMMAND	ON/OFF : 5V 64ms PULSE			
OUTPUTS	1(3-23 Card)	2(0-60 Card)	3	
VOLTAGE (V)	5	5		
MIN CURRENT (mA)				
NOMINAL CURRENT (100%) (mA)	20	1900		
MIN CURRENT (mA)				
PEAK CURRENT (mA)		2500		

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AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

DC_DC_SPS_TYPE

PEAK CURRENT DURATION (ms)				NA	3-4ms every sec	
SETTABILITY (%)				± 3	± 3	
LINE REGULATION (%)				± 3	± 3	
LOAD REGULATION (%)				± 3	± 3	
TURN ON (RISE TIME) (ms)				3		
TURN OFF (FALL TIME) (ms)				3		
RIPPLE (mV) (Pk-Pk)				50	50	
SPIKE (mV)						
DELAY(TURNON)				BETWEEN		BETWEEN
				NA		
DELAY(TURNOFF)				BETWEEN		BETWEEN
				NA		
Weight				0.630kg		
NOTE:						
1	RIPPLE AND SPIKE SHOULD ME MEASURED AT THE LOAD END ACROSS A 0.1uF CAPACITOR WITH A 1X CRO PROBE WITH AS SHORT LEAD AS POSSIBLE.					
2	HARNESS LENGTH SHOULD BE 3 METERS 232 AWG.					
3	THE OUTPUT VOLATGE SHOULD BE MEASURED AT _____					
4	ALL OVERSHOOT AND UNDERSHOOT SHOULD BE within 15% OF NOMINAL O/p VOLTAGE for line transients. (26 to 42 and vice versa) ALL OVERSHOOT AND UNDERSHOOT SHOULD BE within 15% OF NOMINAL O/p VOLTAGE for Load transients (100 to 70% and vice versa)					
5	RISE TIME AND FALL TIME SHOULD BE WITHIN +/- 10% OF SPECIFIED.					
	ANY OTHER REQUIREMENTS / SPECIFICATIONS					

2. PCB DETAILS

CARD	PCB CODE	DIMENSION(mm)	DESCRIPTION
A	NPW36-3-23	# 71 X 95 X 1.6	Forward
B	NPW36-0-60	# 70 X 90 X 1.6	Forward

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Dept. of Space	AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE		
	SEG-TED-DOC-01	Revision-00	Issue Date :14-07-17
	DC_DC_ PBRs		

PRODUCT DESCRIPTION:

This is a high Power, very efficient, isolated, single output DC-DC converter based on boost topology. The output Voltage is 70V and with Peak maximum load of 600W. It is used to provide stable S/C bus voltage. The input voltage range is 26-42V. The switching frequency is 25 KHz. The load and line transient are better than 5% of output voltages. The line and load regulation are excellent. The performance is stable even in the extreme temperature range of -40 to +65 deg. C



1. ELECTRICAL SPECIFICATIONS:

I/P VOLTAGE*	MIN	26
	MAX	42.5
TOPOLOGY	Boost	
SWITCHING FREQUENCY	25KHz $\pm$ 5%	
EFFICIENCY	TYP > 90 %	
OUTPUT POWER	NOMINAL	445W
	PEAK	560W
OUTPUT CURRENT LIMIT THRESHOLD	8A $\pm$ 5% (7.6 A To 8.4A)	
OUTPUT OVP LIMIT (MIN LOAD)**	94V<OVP<100V	
OUTPUT OVP LIMIT (NOMINAL LOAD)**	84V<OVP<90V	
TELEMETRY	O/P VOLTAGE TM (M&R)	0 TO 5V
	INPUT CURRENT TM	0 TO 5V
TELECOMMAND	ON/OFF : 5V 64ms PULSE	
OUTPUTS	1	
VOLTAGE (V)	70 $\pm$ 2V	
MIN. CURRENT (mA) ^{\$}	180	
NOMINAL CURRENT (100%) (A)	6.35	
MAX. CURRENT (A)	8	
PEAK. CURRENT	NA	

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Dept. of Space	AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE		
	SEG-TED-DOC-01	Revision-00	Issue Date :14-07-17
	DC_DC_PBRs		

(mA)	
PEAK CURRENT DURATION (ms)	NA
SETTABILITY (%)	±1
LINE REGULATION (%)	±1
LOAD REGULATION (%)	±1
TURN ON (RISE TIME) (ms)	NA
TURN OFF (FALL TIME) (ms)	NA
RIPPLE (mV) (Pk-Pk) [#]	< 1V±10%
SPIKE (mV)	NA
Weight	3kg

NOTE:

1	RIPPLE AND SPIKE SHOULD BE MEASURED AT THE LOAD END ACROSS A 0.1µF CAPACITOR WITH A 1X CRO PROBE WITH AS SHORT LEAD AS POSSIBLE.
2	HARNESS LENGTH SHOULD BE 1 METER.
3	ALL OVERSHOOT AND UNDERSHOOT SHOULD BE WITHIN 6.3% OF NOMINAL O/P VOLTAGE FOR LINE TRANSIENTS. (26 TO 42 AND VICE VERSA) ALL OVERSHOOT AND UNDERSHOOT SHOULD BE WITHIN 6% OF NOMINAL O/P VOLTAGE FOR LOAD TRANSIENTS (100 TO 28% AND VICE VERSA)
4	[#] OUTPUT IS REGULATED FROM 26V ONWARDS. HOWEVER PROTECTION LOGIC OVP OPERATION IS WELL GUARANTEED FROM 30V ONWARDS. RIPPLE MAY EXCEED THE SPECIFICATION BELOW 30V (1.2 V). [*] THE INPUT AND OUTPUT VOLTAGE SHOULD BE MEASURED AT CONVERTER END WITH NON CURRENT CARRYING WIRES. ^{**} OVP OCCURRENCE LEVEL DEPENDS ON LOAD. OVP OCCURS AT A LOWER LEVEL UNDER FULL LOAD CONDITION AND OCCURS AT A HIGHER LEVEL UNDER LIGHT LOAD CONDITION
5	^{\$} NO LOAD BEHAVIOR OF THE PACKAGE TO BE OBSERVED AND RECORDED.

Dept. of Space	AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE		
	SEG-TED-DOC-01	Revision-00	Issue Date :14-07-17
	DC_DC_ PBRs		

2. PCB DETAILS:

CARD	PCB CODE	DIMENSION (mm)	DESCRIPTION
A	BDR 10-2-05	229*115*2.25	CONTROL CARD
B	BDR 10-1-02	133*199*1.7	CAPACITOR CARD
C	BDR 10-2-03	72*90*2.2	SWITCH CARD

Dept. of Space	AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE		
	SEG-TED-DOC-01	Revision-00	Issue Date :14-07-17
	DC_DC_OBC_TYPE		

PRODUCT DESCRIPTION:

This is a high power, highly efficient, isolated, 3 output DC-DC converter based on Forward topology. It is highly reliable with low component count. Performance of this converter is very stable even at extreme temperatures (-40 to +65°C). It can be used up to a power requirement of 15W-30W with minimal tuning. Since it is a low noise, small size deck mountable DC- DC converter, it finds application in Onboard computer powering applications in LEO/GEO spacecraft. The load and line transients are Less than 5% and the line and load regulations are less than 2% of rated output voltages. *It can also be stacked with the user subsystems or with other OBC DC-DC converters.*



1. ELECTRICAL SPECIFICATIONS:

I/P VOLATGE	MIN	26		
	MAX	42		
TOPOLOGY	NPW36-3-23:	Forward		
	NPW36-2-24:	Forward		
SWITCHIONG FEQUENCY	NPW36-3-23:	110 KHz +- 10 %		
	NPW36-2-24:	90 KHz +- 10 %		
HKB VOLTAGE	NPW36-3-23:	13 V, 30 mA		
	NPW36-2-24:	10 V, 30 mA		
EFFICIENCY	TYP> 70 %			
OUTPUT POWER	NOMINAL	23.4 W		
	PEAK			
CURRENT LIMIT THRESHOLD	NPW36-3-23A:	150% to 200% OF INPUT CUR.		
	NPW36-3-23B:	150% to 200% OF INPUT CUR.		
TELEMETRY	O/P VOLTAGE TM (M&R)	4 TO 5V		
TELECOMMAND	ON/OFF : 5V 64ms PULSE			
OUTPUTS	1	2	3	
VOLTAGE (V)	+6.2	-15.2	+15.2	
MIN. CURRENT (mA)	300	200	300	
NOMINAL CURRENT (100%) (mA)	1800	300	500	
MAX. CURRENT (mA)				
PEAK. CURRENT	3000			

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Dept. of Space	AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE		
	SEG-TED-DOC-01	Revision-00	Issue Date :14-07-17
	DC_DC_ OBC_TYPE		

(mA)				
PEAK CURRENT DURATION (ms)	NA			
SETTABILITY (%)	+/-3	+/-3	+/-3	
LINE REGULATION (%)	+/-3	+/-3	+/-3	
LOAD REGULATION (%)	+/-3	+/-3	+/-3	
TURN ON (RISE TIME) (ms)	<10			
TURN OFF (FALL TIME) (ms)	<10			
RIPPLE (mV) (Pk-Pk)	50	50	50	
SPIKE (mV)	100			
DELAY(TURNON)	BETWEEN		BETWEEN	
	NA			
DELAY(TURNOFF)	BETWEEN 5V and 8V		BETWEEN	
	NA			
Weight	0.550kg			
NOTE:				
1	RIPPLE AND SPIKE SHOULD ME MEASURED AT THE LOAD END ACROSS A 0.1Uf CAPACITOR WITH A 1X CRO PROBE WITH AS SHORT LEAD AS POSSIBLE.			
2	HARNESS LENGTH SHOULD BE 1.2 METERS 22 AWG.			
3	THE OUTPUT VOLATGE SHOULD BE MEASURED AT LOAD END.			
4	ALL OVERSHOOT AND UNDERSHOOT SHOULD BE within 15% OF NOMINAL O/p VOLTAGE for line transients. (26 to 42 and vice versa) ALL OVERSHOOT AND UNDERSHOOT SHOULD BE within 15% OF NOMINAL O/p VOLTAGE for Load transients (100 to 70% and vice versa)			
5	RISE TIME AND FALL TIME SHOULD BE WITHIN +/- 10% OF SPECIFIED.			
	ANY OTHER REQUIREMENTS / SPECIFICATIONS * OPC11,OPC12 are without ON/OFF SPECIFIED			



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

OBC_ VER.1

Output	4V PP NRZ (S) / PSK
On-board storage	4 Mega Bytes
On Board Timer	40 bit counter with 125 μ s resolution for Event Latch Software OBT for On Board Time with 1750 Long float format (31 bit)
GC Interface	NRZS interface for Normal, Dwell
AIT Interface	Clk, NRZL interface for Normal, Dwell
Contingency TM (CTM)	4 kbps with 128 kHz Subcarrier
Analog channels for CTM	10 channels (4pi, Mag, Rx AGC, Battery current)
Status Bit monitored CTM	12 bits (PSK lock sts, Rx Lock sts, OBC Status bits)
Telecommand Subsystem Specifications	
Modulation	PCM/BPSK/PM
Sub-carrier frequency & Bit rate	44 kHz & 4 kbs
Demodulation Technique	Costas Loop
PCM Format	NRZ-L
Command Frame Length	60 bits
Frame sync code	9AF0 (16 bit)
Idle pattern	8 bits alternate 1 & 0 (A5)
Spacecraft ID	
Eb/No required for BER of 1×10^{-5}	13 dB (Typical)
Frame repetition	2 frames
Frame to Frame gap	8 bits of idle pattern
Message to Message gap	16 bits of idle pattern
GCO interface for GC relay	Present: 28V coil operated
Launch Vehicle Interface	Snap Interface – 2 snap signals
Weight	14.85kg



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

OBC_ VER.1

2. PCB DETAILS

CARD	PCB CODE	DIMENSION(mm)	DESCRIPTION
A	OBC-10-0-09	271 * 247	Heater Switching Card
B	OBC-10-0-09	271 * 247	Heater Switching Card
C	OBC-10-0-25	271 * 247	Attitude sensor processing Card
D	OBC-10-1-05	271 * 247	Master Data Acquisition card
E	OBC-10-1-08	271 * 247	APC-OBS card
F	OBC-10-1-12	271 * 247	Thermistor and Analog channels card
G	OBC-10-1-14	271 * 247	Thruster Driver card
H	OBC-10-4-02 + OBC-10-1-22	271 * 247	DC/DC card
I	OBC-10-2-11	271 * 247	MTC card
J	OBC-10-2-18	271 * 247	General Purpose card
K	OBC-10-1-13	271 * 247	PSK card
L	OBC-10-5-07	271 * 247	CPU card
M	OBC10MB-3-01	372* 271	Mother Board



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

OBC_ VER.1

PROJECT	OBC .VER.1	PACKAGE CODE	OBC-10 & OBC-20
MODEL	FLIGHT	PKG. DIMENSIONS (mm)	372(L)*247(W)*271(H)

PRODUCT DESCRIPTION:

The various subsystem functions such as sensor electronics command and house-keeping, attitude and orbit control, thermal management etc., are integrated to a single spacecraft system named OBC. The MIL STD 1553B protocol is used for interfacing with various sub-systems of spacecraft.



1. ELECTRICAL SPECIFICATIONS:

I/P VOLATGE	MIN	26
	MAX	42
LPD	64s/128s for Acq Mode, 2s for Normal mode	
FDI	If WDT is not reset for 256ms, NMI is generated. After 3 consecutive NMIs FDI is generated.	
Telemetry Subsystem Specifications		
TM (N) Bit rate	4 kbps with 32 kHz sub-carrier / 128 kHz sub-carrier	
TM (D) Bit rate	4 kbps with 128 kHz sub-carrier	
Spacecraft ID	16 Hex (Normal)	
Frame length	128 words/frame	
Word length	8 bits/word	
TM (N) sampling rates	0.25 ms / 1s / 2s / 4s / 8s / 16s	
TM (D) sampling rate	8ms per word	
TM/HK playback (on-orbit)	16 kbps with 128 kHz sub-carrier	
Frame sync	24 bits ACCA1F	

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AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

OBC_ VER.1

Frame ID word	6 bits
No. of sub-frames / Channels	64 / 8192 words
Output	4V PP NRZ (S) / PSK
On-board storage	4 Mega Bytes
On Board Timer	40 bit counter with 125 μ s resolution for Event Latch Software OBT for On Board Time with 1750 Long float format (31 bit)
GC Interface	NRZS interface for Normal, Dwell
AIT Interface	Clk, NRZL interface for Normal, Dwell
Contingency TM (CTM)	4 kbps with 128 kHz Subcarrier
Analog channels for CTM	10 channels (4pi, Mag, Rx AGC, Battery current)
Status Bit monitored CTM	12 bits (PSK lock sts, Rx Lock sts, OBC Status bits)
Telecommand Subsystem Specifications	
Modulation	PCM/BPSK/PM
Sub-carrier frequency & Bit rate	44 kHz & 4 kbs
Demodulation Technique	Costas Loop
PCM Format	NRZ-L
Command Frame Length	60 bits
Frame sync code	9AF0 (16 bit)
Idle pattern	8 bits alternate 1 & 0 (A5)
Spacecraft ID	
Eb/No required for BER of 1×10^{-5}	13 dB (Typical)
Frame repetition	2 frames
Frame to Frame gap	8 bits of idle pattern
Message to Message gap	16 bits of idle pattern
GCO interface for GC relay	Present: 28V coil operated
Launch Vehicle Interface	Snap Interface – 2 snap signals
Weight	14.85kg



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

OBC_ VER.1

2. PCB DETAILS

CARD	PCB CODE	DIMENSION(mm)	DESCRIPTION
A	OBC-10-0-09	271 * 247	Heater Switching Card
B	OBC-10-0-09	271 * 247	Heater Switching Card
C	OBC-10-0-25	271 * 247	Attitude sensor processing Card
D	OBC-10-1-05	271 * 247	Master Data Acquisition card
E	OBC-10-1-08	271 * 247	APC-OBS card
F	OBC-10-1-12	271 * 247	Thermistor and Analog channels card
G	OBC-10-1-14	271 * 247	Thruster Driver card
H	OBC-10-4-02 + OBC-10-1-22	271 * 247	DC/DC card
I	OBC-10-2-11	271 * 247	MTC card
J	OBC-10-2-18	271 * 247	General Purpose card
K	OBC-10-1-13	271 * 247	PSK card
L	OBC-10-5-07	271 * 247	CPU card
M	OBC10MB-3-01	372* 271	Mother Board



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

OBC-VER.2

PROJECT	OBC .VER.2	PACKAGE CODE	OBC-10 & OBC-20
MODEL	FLIGHT	PKG. DIMENSIONS (mm)	372(L)*247(W)*271(H)

PRODUCT DESCRIPTION:

Cost-effective spacecraft engineering is achieved by integrating the various elements of the spacecraft bus that realize the functions of Command processing, Data acquisition and processing, Attitude and Orbit control, Telemetry and Housekeeping and Thermal Management into a single OBC framework that uses standard interfaces as well as MIL-STD-1553B with rest of the spacecraft.



1. ELECTRICAL SPECIFICATIONS:

I/P VOLATGE	MIN	28 V
	MAX	42.5 V
AOCS Specifications		
Parameter	Normal mode	SK-mode
Yaw	+/- 0.05 deg	+/- 0.05 deg
Roll	+/- 0.05 deg	+/- 0.05 deg
Pitch	+/- 0.05 deg	+/- 0.05 deg
Telemetry Specifications		
TM (N) Bit rate – Format -I	1 kbps with 32 kHz sub-carrier	
TM (D) Bit rate – Format -II	1 kbps with 128 kHz sub-carrier / Depth – 16 words	
TM- Star sensor – Format -III	1 kbps with 128 kHz sub-carrier in absence of Dwell data	
Spacecraft ID	5 bits	
Frame length	128 words/frame	
Word length	8 bits/word	
TM (N) sampling rates	1s / 2s / 4s / 8s / 16s	
TM (D) sampling rate	8ms per word	
Frame sync	24 bits ACCA1F	

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AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

OBC-VER.2

Frame ID word	4 bits
No. of sub-frames / Channels	16 / 2048 words
Output	4V PP NRZ (S) / PSK
Telecommand Subsystem Specifications	
Data Rate	100 BPS
Modulation	PCM/FSK
Sub-Carriers	3.125 KHz for zero
	5.555 kHz for one
Sub-carrier demodulation	Non-coherent FSK
Frame length	56 bits
Command information	32 bits
Parity	24 bits
Command Data	16 bits
Frame duration	560 millisecond
Message BCH code	1-4 frames (63, 39, 9) shortened to (56, 32, 9)
Weight	13kg

2. PCB DETAILS

CARD	PCB CODE	DIMENSION(mm)	DESCRIPTION
A	OBC-10-0-04	271 * 247	Temperature Sensor Processing Card
B	OBC-10-0-06	271 * 247	CPC-FSK Card
C	OBC-10-0-09	271 * 247	Heater Switching Card
D	OBC-10-0-09	271 * 247	Heater Switching Card
E	OBC-10-0-10	271 * 247	ILV-LAM Card
F	OBC-10-1-12	271 * 247	Thermistor and Analog channels card
G	OBC-10-1-05	271 * 247	Master Data Acquisition card
H	OBC-10-4-02 + OBC-10-0-22	271 * 247	DC/DC card
I	OBC-10-1-14	271 * 247	Thruster Driver card
J	OBC-10-2-11	271 * 247	MTC card
K	OBC-10-5-07	271 * 247	CPU card
L	OBC10MB-0-21	383.5* 271	Mother Board

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AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

PE_SPECS_FORMAT

PROJECT	GEOSAT-I3K type	PACKAGE CODE	I3K POWER ELECTRONICS	
PKGs	NPW 33,34,43,44	PKG. DIMENSIONS (mm)/ Weight (Kg)	410x300x30	3
	NPW 31,32		264x212x222	4.5
	NPW 41,42,81,82		250x180x230	11
	NPW 51, 52		250x190x130	2.3
	BIM: 10 & 20		284x218x150	5

PRODUCT DESCRIPTION:

The Power Electronics of I3K Spacecraft is realised with Core Power Electronics packages , Distribution Packages, Shunt Packages, EED packages and BIM packages for both BUS A & B.



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AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

PE_SPECS_FORMAT

1. ELECTRICAL SPECIFICATIONS:

POWER ELECTRONICS SPECIFICATIONS	
Bus Voltage	42 ± 0.5V in sunlit. 28 to 41V in Eclipse for bus system
Ripple Voltage	Up To 1% of Bus Voltage.
MAX. Frequency	10 KHZ
Total Bus Capacitance	1978 Micro Farad / Per Bus
Maximum Load Current	70 Amps/Bus (In Sunlit Condition) 80 Amps/battery for the min battery Voltage of 28v (In Eclipse)
Solar Array Power Strings	24
Charger Strings	4
Solar Array Current Sensor	0A TO 50A (LR) 45A TO 95A HR)
TM Resolution	149MA / COUNT (FOR BOTH LR & HR)
Battery Discharge Current	0A TO 50A (LR) 45A TO 95A (HR)
TM Resolution	176MA / COUNT (FOR BOTH LR & HR)
Battery Charge Current Sensor	0A TO 15A. (BAT 1 & 2)
TM Resolution	58MA / COUNT (BAT 1 &2)



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

PE_SPECS_FORMAT

Battery under Voltage Protection [UVP]	3.0 ± 0.05V FOR ANY CELL
Battery Overcharge Protection	4.2 ± 0.05V FOR ANY CELL (BY COMMAND)
Battery Reverse Current Trip Level	16.5A ± 1A
Battery Excess Current Trip Level	150 A ± 5%
Individual Cell Monitoring	2.5V TO 4.5V (COARSE) 3.2V TO 4.2V (FINE)
DOMESTIC DC/DC CONVERTER	
No. Of Converters	2
Input voltage	28 to 43V
Output voltage	+15V,-15V and +5V
Line regulation/Load Regulation	± 3%
Ripple	< 100mV p-p A/c 0.1 uf Capacitor
Spike	< 500mV p-p
Frequency of operation	25 ± 10% kHz
Dump across the Battery	18 ohms
EED CIRCUIT	
Squibb resistance	1 ± 0.2 ohms.
Recommended Fire Current (RFC)	5A, <10 ms
Range for fire current	4 A < RFC < 8A (64mS)

2. PCB DETAILS:

CARD	PCB CODE	DIMENSION(mm)	DESCRIPTION
Core Power	CPW 11-0-01	228.6x200.66x1.6	TMTC Card
	CPW 11-0-02	228.6x200.66x1.6	Domestic regulator
	NPW 31-0-03	228.6x200.66x2.25	Isolation relays, 'OR'ing
	NPW 31-1-01	228.6x200.66x1.7	Logic Card
	NPW 31-1-02	228.6x200.66x1.7	Current Sensor
	NPW 31-MB-104	228.6 X 200 X2.2	Motherboard

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AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

PE_SPECS_FORMAT

Shunt	NPW 33-7-01	216X190X1.7	Shunt Comparator Card
	NPW 33-4-02	216X190x1.7	Shunt switches Card
Distribution	NPW-41-3-01-01	260.36 x 220.35x2.2	Charger strings card
	NPW-41-2-02-01	260.36 x 220.35x2.2	TMTC card
	NPW-41-2-21-01	260.36 x 220.35x2.5	Fuse card
	NPW-41004(In NPW41 & 42)	192x139x2.2	Bus capacitors & fuse networks for charger strings, reconditioning paths
	NPW-41-2-05-01	260.36 x 220.35x2.2	Relay driver
	NPW-41-0-13-01(InNPW81&82)	139 x 192 x 2.2	Bus capacitor & bus parallel fuses card
	NPW-41-0-14-01	70.46 X 31 x 1.7	MOSFET drive resistors
	NPW-41-0-15-01	90x30x1.7	Diode card
	NPW-42-2-02-01(InNPW41&42)	145 x 97x1.7	Coil Mounting PCB (BACS 1&2)
	NPW-82-1-01-01(InNPW81&82)	145 x 97x1.7	Coil Mounting PCB(SACS 1 &2)
EED	NPW 51-1-01	180.00x170.0x1.7	Group arm, disarm, fire, EED Enable & Disable Relays
BIM	NPW60-0-03-01	243.6 x 200.6x2.2	Cell Bypass Card
	NPW60-0-04-01	243.6 x 200.6x2.2	TM Card
	NPW60-0-05	243.6 x 200.6x2.2	TC Card
	NPW60-3-06-01	243.6 x 200.6x2.2	ACO Card
	NPW60-4-01-00	243.6 x 200.6x2.2	ICM Card
	NPW60-4-02-00	243.6 x 200.6x2.2	Protection Card
	NPW60MB-0-03-00	232.4 x 144.5x2.25	Mother Board



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

PE_SPECS_FORMAT

PROJECT	IRNSS	PACKAGE CODE	R1XPW: 31, 33, 41 & 51	
PACKAGES	Core Power	PKG. DIMENSIONS (mm) / Weight (Kg)	264x216x185	5
	Shunt		324x290x65	3
	Distribution		278x323x254	11
	EED		241x190x105	2.8

PRODUCT DESCRIPTION:

The Power Electronics of IRNSS Space Segment is realised with Power Control packages , Distribution Packages, Shunt Packages & EED packages.





AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

PE_SPECS_FORMAT

1. ELECTRICAL SPECIFICATIONS:

BUS:	
1. Main Bus –Sunlit Condition Eclipse Condition	42.25V±0.3V 26V TO 42.5V
2. Battery Charging Scheme	Through charger String
3. Total No Of Solar Array String	16
4. No Of Charger String	4
5. Solar array current sensor SACS (LR) Input Range	0 TO 20A
O/p range(TM)	0 to 255 counts
SACS HR) Input Range	16A TO 45A
O/p range(TM)	0 to 255 counts
6. Battery current sensor LR Input Range O/p range(TM) HR Input Range O/p range(TM) Battery Charge Input Range O/p range(TM)	0A TO 20A 0 to 255 counts 16A TO 45A 0 to 255 counts 0 TO 12A 0 to 255 counts
7. Battery Cell under voltage protection	3.0V ± 0.05V
8. Battery Cell over charge protection	4.20V ± 0.05V
9 Battery ECL trip level	>96A
10. Battery dynamic RCL trip level	Max charger string Isc +1A
11. Fine cell voltage monitoring	3.2V to 4.2V
12. Coarse cell voltage monitoring	2.5V to 4.3V
13. Battery voltage Fine Input Range O/p range(TM) Coarse Input Range O/p range(TM)	32V TO 42V 0 to 255 counts 25V TO 43V 0 to 255 counts



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

PE_SPECS_FORMAT

14. EOC Data set

Input Range
O/p range(TM)

32V TO 42V (00 to FF HEX data)
0 to 255 counts

DOMESTIC DC-DC CONVERTER

1. Topology	Resonant reset forward.
2. No. of Converters	2
3. Input Voltage	23 to 43V
4. Output voltages/loads	+6V/250mA,+15V/1.2A& -15V/800mA
5. Line regulation/load regulation	+/- 3%
6. Efficiency	>75%
7. Output power	30W

2. PCB DETAILS

CARD	PCB CODE	DIMENSION(mm)	DESCRIPTION
Core Power	R1AP 31-0-01	228.6X200.65X2.2	ICM/BVM/EOC Card
	R1AP 31-0-02	228.6X200.65X2.2	TMTC Card
	R1AP 31-0-03	228.6X200.65X2.2	Cell Bypass Card
	R1AP 31-0-04	231.2X200.65X2.2	DOMREG Card
	R1AP 31-MB-001	232.4X118X2.25	Mother Card
Shunt	NPW 34-0-02	216X190X1.7	Switch Drive Card
	NPW 34-0-01	216X190X1.7	Comparator Card
	NPW 33-0-04	216X190X1.7	MVL/Capacitor Card
Distribution	NPW 41-2-05	260.36 x 220.35x2.2	Relay Driver Card
	NPW 41-2-02	260.36 x 220.35x2.2	TM/TC Card
	NPW 41-0-18	260.36 x 220.35X2.2	Fuse Card
	NPW 41-2-21	260.36 x 220.35X2.2	High Power Fuse

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AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

PE_SPECS_FORMAT

			Card
	NPW 41-3-01	260.36 x 220.35x2.2	Charger Card
	NPW 41-1-22	192X139X2.2	Current Sense Network Card
	NPW 42-1-04	97X110X2	Current Sense Amplifier (M & R)
	NPW 41-0-14	70.46 X 31 x 1.7	MOSFET Resistor Card
EED	R1APW 51-0-01	180X170X1.75	EED Powering card

** ALL THE CARD DIMENSIONS FOR IRNSS POWER PKGS ARE BASED ON MECHANICAL DRAWINGS



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

PE_SPECS_FORMAT

PROJECT	IRS (Dual Bus)	PACKAGE CODE	PW: 10, 11, 20 & 21 PE: 10	
PACKAGE FOLDER NO.	Core Power	PKG. DIMENSIONS (mm)/ Weight (Kg)	264x406x120	4.1
	Distribution		310x213x186	6.5
	EED		236x213x186	2.6

PRODUCT DESCRIPTION:

The Power Electronics for IRS type Dual Bus Power system is realised with Core Power Electronics packages, Distribution Packages & EED Packages.



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AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

PE_SPECS_FORMAT

1. ELECTRICAL SPECIFICATIONS:

BUS (BATTERY CLAMPED)	
No. Of Buses	2
Voltage Range	28-43V
BUS REGULATION / CHARGE CONTROL (PWM BASED TCR)	
No. Of SA Strings/Bus	10
No. Of PWM Strings	2 (M&R) per bus
No. Of ON/OFF Strings	8
String No.1 & 2	3.8A
String No. 3	2.6A
String No.4 - 10	3.15A
Charge Current	0 to 20A (Settable)
Taper Voltage Range	37.5V to 43.4V
Taper Accuracy	$\pm 0.2V$
PROTECTION FEATURES	
A] Auto changeover logic for TCR	
By Over Voltage Control	$42.4 \pm 0.1V$
B] Emergency Logic	
B1) Conventional Logic (CL) (MAIN)	
Battery total voltage	$28.5 \pm 0.3 V$
Minimum Delay For Activation	1 Sec (± 0.5 sec)
B2) Conventional Logic (CL) (REDT)	
Battery Total Voltage	$28.5 \pm 0.3 V$
Minimum delay for activation	1 Sec (± 0.5 sec)
Telemetry channels	
A] Voltage Sensing	
A1) Bus voltage	
Input Range	0-43 V
Output range (TM)	0-5 V
A2) Battery Voltage Channel -1	
Input Range	24V to 43V -5V to + 5V

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AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

PE_SPECS_FORMAT

Output range(TM)	
A3) Battery Voltage Channel -2 Input Range Output Range(TM)	37V to 42.5V -5V to + 5V
B] Current sensing B1] Solar Array Current Sensor (SACS) Input current range Output voltage(TM)	0 to 30A 0 to 5V
B2] Battery Current Sensor Current range Output Voltage	0 to 20A Charge /0 to 20A discharge -5V to +5V ('-ve during discharge)
DOMESTIC DC/DC CONVERTER	
No. Of Converters	2
Topology	Push-Pull
Input voltage	28 to 43V
Output voltage	$\pm 13.5V$ for DOMREG-1, $\pm 12.5V$ for DOMREG-2 + 5.6V for both
Protections	Hicc-Up for over load (I/P @ 900 mA) OVP for over voltage ($\pm 16.3V$, +7.3V)
Total Input power from Raw bus	~ 8W
Line regulation/ Load Regulation	$\pm 1\%$
Ripple	< 100mV p-p A/c 0.1 uF
Spike	< 500mV p-p
Frequency of operation	22-25 KHz

2. PCB DETAILS

CARD	PCB CODE	DIMENSION(mm)	DESCRIPTION
Core Power	CPW11-0-01	228.6x200.66x1.6	TMTC with remote decoder Card
	CPW11-0-02	228.6x200.66x1.6	DOMREG Card
	CPW11-0-03	228.6x200.66x1.6	ICM card
	IP5PW 11-0-01	228.6x200.66x1.6	EM Logic,OVP &

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AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

PE_SPECS_FORMAT

			AMUX Card
	IP5PW11-0-02	228.6x200.66X1.7	TCR M&R Card
	IP5PW11-1-03	228.6x200.66X1.6	TCR Auto C/O Card
	IP5PW11MB-0-01	NA	Mother Board
Distribution	IP5PW10-1-01	339.47x256.64X2.3	Shunt Switches
	IP5PW10-0-02	174.5x256.41X2.3	Current Sensors and EM Relays
	IP5PW10-1-03	339.4x256.42X2.2	Fuse Distribution and DMUX
EED	NPW51-1-01 A,B,C &D	180.00x170.0x1.7	EED Powering Card



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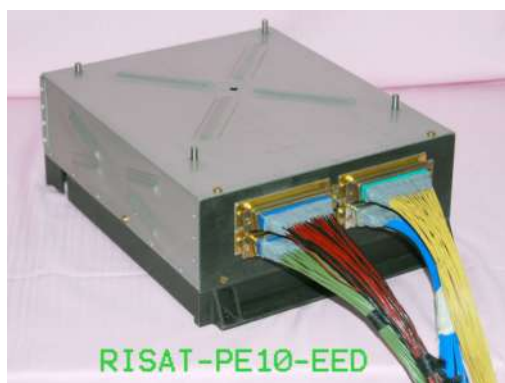
SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

PE_SPECS_FORMAT

PROJECT	IRS (Single Bus)	PACKAGE CODE	MPW: 10 & 11	
PACKAGES	Core power	PKG. DIMENSIONS (mm)/ Weight (Kg)	264x213x186	4.5
	Distribution		310x406x120	6.3



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AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

PE_SPECS_FORMAT

1. ELECTRICAL SPECIFICATIONS FOR SINGLE BUS:

BUS (BATTERY CLAMPED)	
No. Of Buses	1
Voltage Range	28-42V
BUS REGULATION / CHARGE CONTROL (PWM BASED TCR)	
No. Of SA Strings/Bus	16
No. Of PWM Strings	2 (M&R) per bus
No. Of ON/OFF Strings	14
String No.1 & 2	2.26A
String No. 3 to 6	1A
String No.7, 8, 15, 16	0.478A
String 9 to 14	1.37A
Charge Current	0 to 10A (Settable)
Taper Voltage Range	36V to 42V
Taper Accuracy	$\pm 0.2V$
PROTECTION FEATURES	
A] TM- Clk freq TC- Clk freq	40KHz 8 KHz
B] Auto changeover logic for TCR By Over Voltage Control	$42.4 \pm 0.1V$
C] Emergency Logic (Conventional Logic (CL)) Battery over voltage control	$42.4 \pm 0.2 V$
Telemetry channels	
A] Voltage Sensing A1) <u>Bus voltage before/after emergency relay</u> Input Range Output range (TM)	0-45 V 0-5 V
A2) Battery Voltage (COARSE) Input Range Output range(TM)	25V to 45V -5V to + 5V

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AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

PE_SPECS_FORMAT

B] Current sensing

B1] Solar Array Current Sensor (SACS)

Input current range

0 to 30A

Output voltage(TM)

0 to 5V

B2] Battery Current Sensor

Current range

0 to 20A Charge /0 to 30A discharge

Output Voltage

-5V to +5V ('-ve during discharge)

DOMESTIC DC/DC CONVERTER

No. Of Converters	2
Input voltage	28 to 42V
Output voltage	+12V / 200mA, -12V / 110mA, + 5V / 15mA
Frequency	22 to 25 KHz
Volt TM	0 to 16V corresponding to 0 to 5V
Cur TM	0 to 1.5A corresponding to 0 to 5V
Line regulation/ Load Regulation	± 1%
Ripple	< 100mV p-p
Spike	< 500mV

2. PCB DETAILS

CARD	PCB CODE	DIMENSION(mm)	DESCRIPTION
Core Power	CPW11-0-01	228.6x200.66x1.6	TMTC with remote decoder Card
	CPW11-0-02A&B	228.6x200.66x1.6	DOMREG Card
	CH1PW11-0-01	228.6x200.66x1.6	EM Logic, OVP & AMUX Card
	IP5PW11-0-02	228.6x200.66x1.7	TCR M&R Card
	IP5PW11-1-03	228.6x200.66x1.6	TCR Auto C/O Card
	EMPW11-0-01	228.6x200.66x2.25	Emergency logic card
	CPW11-0-01	228.6x200.66x1.6	TMTC with remote decoder Card
Distribution	IP5PW10-1-01	339.47x256.64X2.3	Shunt Switches
	IP5PW10-0-02	174.5x256.41X2.3	Current Sensors and EM Relays
	IP5PW10-1-03	339.4x256.42X2.2	Fuse Distribution and DMUX

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AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-C-RX-01

Revision-00

Issue Date :14-07-17

C-BAND RECEIVER_01_SPECS_FORMAT

PROJECT	ALL GEOSAT (42V) TYPE	PACKAGE CODE	NCM 220/221
MODEL	FLIGHT	PKG. DIMENSIONS (mm)	216x153x116 mm3

PRODUCT DESCRIPTION:

This Receiver works on 42V RAW Bus supply. It receives and demodulates the command signal transmitted on an uplink carrier from ground station. Provide input to the Command Decoders for command execution. The onboard receiver provides the command data at the rate of 500 bps and the required clocks to the command decoder onboard. The demodulation scheme is FM/FSK/PCM. It also demodulates the ranging tone information from the transmitted uplink carrier.



C-Band Receiver Type-1

1. ELECTRICAL SPECIFICATIONS:

1.	Raw Bus Voltage	MIN	26V
		MAX	42V
2.	Modulation scheme for Telecommand	PCM/FSK/FM (± 400 KHz deviation)	
3.	DC Power Consumption	5 Watts (max)	
4.	Frequency	C-Band (6.4 Ghz)	
5.	Dynamic range	-60 dBm to -110 dBm (command) -60 dBm to -103 dBm (ranging)	
6.	Command Threshold	-110 dBm	
7.	Minimum command SNR (at threshold -110 dBm)	+19 dB in 400 Hz tone filter	
8.	Command Channel output level	2 Vp-p to 12 Vp-p	
9.	Ranging threshold for any tone frequency	-103 dBm for ranging SNR of +13 dB at the ranging output (65 KHz filter)	
10.	Band width	1.2 MHz at IF (3 dB)	
11.	Receiver output impedance	1KOhm(for command and ranging channels)	
12.	Image freq. rejection	80 dB (with preselect filter)	
13.	Spurious leakage	-110 dBm in any 4 KHz band at receiver input (with filter)	
14.	Overload protection	-50 dBm in pass band (+100 MHz BW) 0 dBm at outside the pass band	
15.	Input VSWR	better than 1.5	
16.	Weight	2.2Kg	

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AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-C-RX-01

Revision-00

Issue Date :14-07-17

C-BAND RECEIVER_01_ SPECS _ FORMAT

2. PCB DETAILS

SL No.	PCB CODE	DIMENSION(mm)	DESCRIPTION
1	NR-001	#	LNA BLOCK
2	NR-002	#	
3	NR-103		
4	NR-104		
5	NR-005		
6	NR-106	88.0 X 44.0	1ST Mixer, 1ST IF AMP & 199MHz SAW BPF
7	NR-107	38.0 X 72.0	2nd mixer and 2nd IF amplifier
8	NR-408	70.0 X 70.0	2ND IF AMP & 21.4MHz SAW BPF
9	NR-309	52.0 X 60.0	Limiter and FM discriminator
10	NR-110	35.0 X 70.0	HMC LNA bias
11	NL-012	115.0 X 36.0	177MHz Amplifier & Power Divider
12	NL-113	63.0 X 50.0	X7 frequency multiplier
13	NL-114	37.0 X 50.0	1.2 GHz BPF
14	NL-115	115.0 X 32.0	1.2 GHz Amplifier
15	NL-116	98.5 X 62.0	X5 Frequency multiplier & 6.2GHz BPF
16	NC-111	67.0 X 48.0	HMC base band filter + Video amplifier
17	NC-317	58.0 X 40.0	EMI Filter & Supply Distribution card
18	NC-118	40.0 X 70.0	Raw bus fuse card



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-C-RX-02

Revision-00

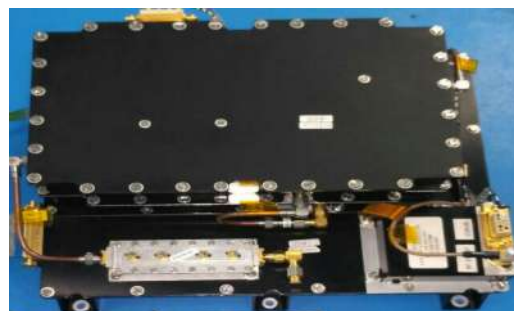
Issue Date :14-07-17

C-BAND RECEIVER_02_SPECS_FORMAT

PROJECT	ALL IRNSS TYPE	PACKAGE CODE	R1NCM 220/221
MODEL	FLIGHT	PKG. DIMENSIONS (mm)	244x216x85 mm3

PRODUCT DESCRIPTION:

This Receiver works on 42V RAW Bus supply. It receives and demodulates the command signal transmitted on a uplink carrier from ground station. Provide input to the Command Decoders for command execution. The onboard receiver provides the command data at the rate of 500 bps and the required clocks to the command decoder onboard. The demodulation scheme is FM/PSK/PCM. It also demodulates the ranging tone information from the transmitted uplink carrier.



C-Band Receiver Type-2

1. ELECTRICAL SPECIFICATIONS:

1.	RAW BUS VOLTAGE		MIN	23V
			MAX	42.5V
2.	MODULATION SCHEME FOR	TELECOMMAND	PCM/PSK/FM ($\pm$ 400 KHZ DEVIATION)	
		Ranging	FM (+ 400 kHz deviation)	
3.	DC POWER CONSUMPTION		12 WATTS (MAX)	
4.	FREQUENCY		C-BAND (6.4 GHZ)	
5.	DYNAMIC RANGE		-60 DBM TO -110 DBM (COMMAND)	
			-60 DBM TO -103 DBM (RANGING)	
6.	COMMAND CHANNEL OUTPUT		DATA : 5 VP-P $\pm$ 5% (NRZ) CLOCK : 5V/0V, 500HZ WITH DUTY CYCLE 50 $\pm$ 5% (SQUARE WAVE) GATED LOCK : 3.5 TO 5.5V FOR LOCK & 0 TO 1.5V FOR UNLOCK (DC)	
7.	COMMAND THRESHOLD		-110 DBM	
8.	RANGING THRESHOLD FOR ANY TONE FREQUENCY		-103 DBM FOR RANGING SNDR OF 60DB-HZ AT THE RANGING OUTPUT (60 KHZ FILTER)	
9.	Ranging output level		5V $\pm$ 5% (when measured across 1k Ω load) for an input of -100dBm at ambient condition. The output varies in the range of 5V + 10% to 5V - 20% over the dynamic range and over the operating temperature range of - 250C to +550C	
10.	RECEIVER OUTPUT IMPEDANCE		1Kohm(FOR COMMAND AND RANGING CHANNELS)	
11.	Image freq. rejection		53 dB (with preselect filter)	
12.	Spurious leakage		-110 dBm in any 4 kHz band at Rx input (with PSF)	
13.	Overload protection		-50 dBm in pass band (+100 MHz BW) 0 dBm at outside the pass band	

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SEG-TED-C-RX-02

Revision-00

Issue Date :14-07-17

C-BAND RECEIVER_02_ SPECS _ FORMAT

14.	Input VSWR	better than 1.5
15.	Weight	2.56Kg

2. PCB DETAILS

SL No.	PCB CODE	DIMENSION(mm)	DESCRIPTION
1	NR-001	#	LNA BLOCK
2	NR-002	#	
3	NR-103		
4	NR-104		
5	NR-005		
6	NR-106	88.0 X 44.0	1ST Mixer, 1ST IF AMP & 199MHz SAW BPF
7	NR-107	38.0 X 72.0	2nd mixer and 2nd IF amplifier
8	NR-408	70.0 X 70.0	2ND IF AMP & 21.4MHz SAW BPF
9	NR-309	52.0 X 60.0	Limiter and FM discriminator
10	NR-110	35.0 X 70.0	HMC LNA bias
11	NL-012	115.0 X 36.0	177MHz Amplifier & Power Divider
12	NL-113	63.0 X 50.0	X7 frequency multiplier
13	NL-114	37.0 X 50.0	1.2 GHz BPF
14	NL-115	115.0 X 32.0	1.2 GHz Amplifier
15	NL-116	98.5 X 62.0	X5 Frequency multiplier & 6.2GHz BPF
16	NC-120		
17	NC-119		
18	R1ATCCR001		



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-C-RX-03

Revision-00

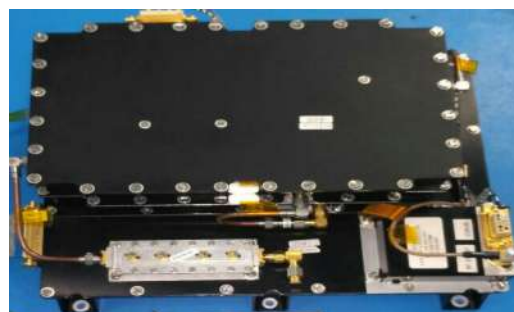
Issue Date :14-07-17

C-BAND RECEIVER_03_ SPECS _ FORMAT

PROJECT	ALL GEOSAT (72V) TYPE	PACKAGE CODE	NCM 320/321
MODEL	FLIGHT	PKG. DIMENSIONS (mm)	284 × 222 × 91.5

PRODUCT DESCRIPTION:

This Receiver works on 72V RAW Bus supply. It receives and demodulates the command signal transmitted on an uplink carrier from ground station. Provide input to the Command Decoders for command execution. The onboard receiver provides the command data at the rate of 500 bps and the required clocks to the command decoder onboard. The demodulation scheme is FM/PSK/PCM. It also demodulates the ranging tone information from the transmitted uplink carrier.



C-Band Receiver Type-3

1. ELECTRICAL SPECIFICATIONS:

1.	Raw Bus Voltage	MIN	42V
		MAX	72.5V
2.	Modulation scheme for Telecommand	FM /PSK / PCM (NRZ-L) ($\pm$ 400 KHz deviation)	
3.	DC Power Consumption	10 Watts (max)	
4.	Frequency	C-Band (6.4 Ghz)	
5.	Bandwidth (1dB)	30 MHz	
6.	Insertion Loss	< 1.7dB	
7.	Return Loss	> 15dB	
8.	Rejection	fc $\pm$ 200MHz	> 70 dBc
		3.7 GHz to 6.2 GHz	> 70 dBc
		6.6 GHz to 7.4 GHz	> 70 dBc
9.	Spurious(7.4GHz - 9.6GHz)	> 40dBc	
10.	input VSWR	1.5:1 (max)	
11.	Subcarrier frequency	8 KHz	
12.	Bit rate	500 bps	
13.	Dynamic range	-60 dBm to -110 dBm (command)	
		-60 dBm to -103 dBm (ranging)	
14.	Command Channel output	Data : 5 Vp-p $\pm$ 5% (NRZ) Clock : 5V/0V, 500Hz with duty cycle 50 $\pm$ 5% (square wave) Gated lock : 3.5 to 5.5V for lock & 0 to 1.5V for unlock (DC)	
15.	Command Threshold	-110 dBm	
16.	Ranging threshold for any tone frequency	-103 dBm for ranging SNDR of 60dB-Hz at the ranging output (60 kHz filter)	
17.	Receiver output impedance	1KOhm (for command and ranging channels)	
18.	Weight	3 Kg	

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AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-C-RX-03

Revision-00

Issue Date :14-07-17

C-BAND RECEIVER_03_SPECS_FORMAT

2. PCB DETAILS

SL No.	PCB CODE	DIMENSION(mm)	DESCRIPTION
1	NR-001	#	LNA BLOCK
2	NR-002	#	
3	NR-103		
4	NR-104		
5	NR-005		
6	NR-106	88.0 X 44.0	1ST Mixer, 1ST IF AMP & 199MHz SAW BPF
7	NR-107	38.0 X 72.0	2nd mixer and 2nd IF amplifier
8	NR-408	70.0 X 70.0	2ND IF AMP & 21.4MHz SAW BPF
9	NR-309	52.0 X 60.0	Limiter and FM discriminator
10	NR-110	35.0 X 70.0	HMC LNA bias
11	NL-012	115.0 X 36.0	177MHz Amplifier & Power Divider
12	NL-113	63.0 X 50.0	X7 frequency multiplier
13	NL-114	37.0 X 50.0	1.2 GHz BPF
14	NL-115	115.0 X 32.0	1.2 GHz Amplifier
15	NL-116	98.5 X 62.0	X5 Frequency multiplier & 6.2GHz BPF
16	NC-021		
17	NC-120		
18	NC-119		
19	R1ATCCR001		PSK Demodulator



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-C-TX-01

Revision-00

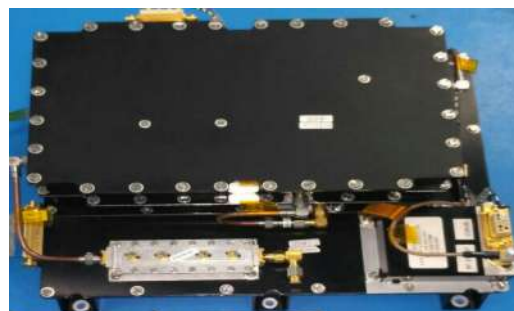
Issue Date :14-07-17

C-BAND TRANSMITTER_01_SPECS_FORMAT

PROJECT	ALL GEOSAT (42V) & IRNSS TYPE	PACKAGE CODE	NCM110/111 R1NCM110/111
MODEL	FLIGHT	PKG. DIMENSIONS (mm)	240x147x72 mm3

PRODUCT DESCRIPTION:

This Transmitter works on 42V RAW Bus supply. It downlinks the Spacecraft telemetry data to control stations in phase modulated format. The signal input from Baseband system to the RF Transmitter is PCM/PSK at subcarrier frequency of 32 KHz & 128 KHz with 2 KHz data rate.



C-Band Transmitter Type-1

1. ELECTRICAL SPECIFICATIONS:

1.	Raw Bus Voltage	MIN	26V
		MAX	42V
2.	Modulation	scheme for Telecommand	PCM/PM
		Distortion	5% (Max)
		Frequency response	283 Hz to 65 KHz (+ 0.5 dB)
		Modulation index	0.9 rad (nominal)
		Index stability	+ 10% (over the temp range of -25 ⁰ C to +55 ⁰ C)
		Residual AM	5% (Max)
3.	Spectral purity	Harmonics	
		Spurious @ 1MHz away from centre frequency	<-50 dBc (In any 4 KHz
		Spurious @ In 5850MHz to 6410MHz & 6735MHz to 6975MHz frequency band	<-110 dBm (in any 4 KHz BW) <-83 dBm (in any 1.5 MHz BW) <-69 dBm (in any 36 MHz BW)
		Spurious @ Over entire 5850 to 6410 MHz & 6735 to 6975MHz frequency band	<-65 dBm
4.	DC Power Consumption	Low Power Mode : 6 Watts (max) High Power Mode : 23 Watts (max)	
5.	Frequency	C-Band (4.2 Ghz)	
6.	Output power	+35 dBm (HP Mode) +26 dBm (LP Mode)	
7.	Frequency settability	± 1 ppm (at a temperature 25 ⁰ C± 2 ⁰ C)	
8.	Frequency stability	Within 4 ppm (over the temp range of -25 ⁰ C to +55 ⁰ C)	
9.	Frequency aging	± 1 ppm/ year	
10.	Weight	2.3 Kg	

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SEG-TED-C-TX-01

Revision-00

Issue Date :14-07-17

C-BAND TRANSMITTER_01_SPECS_FORMAT

2. PCB DETAILS

SL No.	PCB CODE	DIMENSION(mm)	DESCRIPTION
1	C-101	55X25	Phase modulator & Amplifier
2	C-402	30X25	Frequency multiplier
3	C-003	40X25	Band-pass filter
4	C-304	30X25	2 stage BJT Amplifier
5	C-304	30X25	
6	C006	21X25	LPA Chain
7	C-020	42X25	
8	C-021	43.4X25	
9	C-022	21.7X25	
10	C-205	15.4X25	
11	C-214	30X10	
12	C-214	30X10	HPA Chain
13	C-111	20X25	
14	C-112	38X25	LPA Module
15	C-124	15X25	
16	C-125	15X25	
17	C-128	24.4X25	
18	C-129	40X10	
19	C-126	15X25	
20	C-127	15X25	Control Card
21	C-717	160X40	



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-C-TX-02

Revision-00

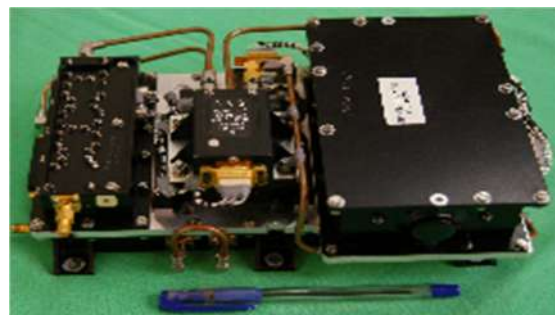
Issue Date :14-07-17

C-BAND TRANSMITTER_02_SPECS_FORMAT

PROJECT	ALL GEOSAT (72V) TYPE	PACKAGE CODE	NCM 110/111
MODEL	FLIGHT	PKG. DIMENSIONS (mm)	242x 161x 108

PRODUCT DESCRIPTION:

This Transmitter works on 72V RAW Bus supply. It downlinks the Spacecraft telemetry data to control stations in phase modulated format. The signal input from Baseband system to the RF Transmitter is PCM/PSK at subcarrier frequency of 32 KHz & 128 KHz with 2 KHz data rate.



C-Band Transmitter Type-2

1. ELECTRICAL SPECIFICATIONS:

1.	Raw Bus Voltage		MIN	42V
			MAX	72V
2.	Modulation	scheme	PCM/PM	
		Distortion	5% (Max)	
		Frequency response	283 Hz to 65 kHz (± 0.5 dB)	
		Modulation index	0.9 rad (nominal)	
		Index stability	$\pm 10\%$ (over the temp range of -25°C to $+55^{\circ}\text{C}$)	
		Residual AM	5% (Max)	
3.	DC Power Consumption		Low Power Mode : 6 Watts (max) High Power Mode : 23 Watts (max)	
4.	Frequency		C-Band (4.2 Ghz)	
5.	Output power		+35 dBm (HP Mode) +26 dBm (LP Mode)	
6.	Frequency settability		± 1 ppm (at a temperature $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$)	
7.	Frequency stability		± 2 ppm (over the temp range of -25°C to $+55^{\circ}\text{C}$)	
8.	Frequency aging		± 1 ppm/ year	
9.	Spectral purity	Harmonics	Less than -50 dBc	
		Spurious @ 1MHz away from the centre frequency	<-50 dBc (In any 4 kHz BW)	
		Spurious @ 5850MHz to 6410MHz & 6735MHz to 6975MHz frequency band	<-110 dBm (in any 4 kHz BW) <-83 dBm (in any 1.5 MHz BW) <-69 dBm in any 36 MHz BW	
		Spurious @ Over entire 5850 to 6410 MHz & 6735 to 6975MHz frequency band	<-65 dBm	
10.	Weight		2.2Kg	

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Revision-00

Issue Date :14-07-17

C-BAND TRANSMITTER_02_SPECS _ FORMAT

2. PCB DETAILS

SL No.	PCB CODE	DIMENSION(mm)	DESCRIPTION
1	C-101	55X25	Phase modulator & Amplifier
2	C-402	30X25	Frequency multiplier
3	C-003	40X25	Band-pass filter
4	C-304	30X25	2 stage BJT Amplifier
5	C-304	30X25	
6	C006	21X25	LPA Chain
7	C-020	42X25	
8	C-021	43.4X25	
9	C-022	21.7X25	
10	C-205	15.4X25	
11	C-214	30X10	
12	C-214	30X10	
13	C-111	20X25	HPA Chain
14	C-112	38X25	
15	C-124	15X25	LPA Module
16	C-125	15X25	
17	C-128	24.4X25	
18	C-129	40X10	
19	C-126	15X25	
20	C-127	15X25	
21	C-917	160X40	Control Card



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-S-RX &
LO-01

Revision-00

Issue Date :14-07-17

S-BAND RECEIVER & LOCAL OSCILLATOR_ 01_SPECS _FORMAT

PROJECT	ALL IRS TYPE	PACKAGE CODE	SRX-21/22 (Receiver) SLO-31/32 (LO)
MODEL	FLIGHT	PKG. DIMENSIONS (mm)	250 x 143 x 87 (Receiver) 265 x 143 x 62 (LO)

PRODUCT DESCRIPTION:

This Receiver works on 42V RAW Bus supply. Each S-Band transponder consists of a receiving and a transmitting system and can operate in either coherent or non-coherent mode. In the coherent mode of operation, the downlink carrier is derived by PLL technique from the uplink signal. Once the on board signal acquires and locks on to the ground transmitted carrier after a single sweep of the uplink carrier, a coherent drive is generated which serves as a source for the downlink carrier. In the non-coherent mode of operation, the downlink carrier is derived from an independent TCXO.

Selection of coherent / non-coherent mode of operation is by ground command. S-Band Receiver receives and demodulates the command signal transmitted on an uplink carrier from ground station. Provide input to the Command Decoders for command execution.



S-Band Receiver



S-Band LO

1. ELECTRICAL SPECIFICATIONS:

1.	Raw Bus Voltage	MIN	28V
		MAX	42V
2.	Frequency	S-Band (2.2 Ghz)	
3.	Carrier tracking range	125 KHz	
4.	Sweep rate for acquisition	32 KHz / sec	
5.	Noise Figure	7 dB (max)	
6.	Dynamic range	Carrier acquisition range	-120 dBm to -50 dBm
		Command demodulation	-105 dBm to -50 dBm SNR of ≥ 18.75 dB in 400 Hz sub-carrier filter BW
		Ranging	-90 dBm to -50 dBm SNR of ≥ 13 dB in ranging filter BW.
7.	Modulation parameters Command	Modulation format received	PCM / FSK / FM / PM
		PM index	0.6 rad
		FM subcarrier frequency	70 KHz

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AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-S-RX &
LO-01

Revision-00

Issue Date :14-07-17

S-BAND RECEIVER & LOCAL OSCILLATOR_ 01_SPECS _FORMAT

8.	Modulation parameters Ranging	Modulation format received	PM
		Modulation indices	Major tone : 1 rad. Minor tone : 0.45 rad
9.	Weight	2.5Kg (Receiver) 1.2Kg (LO)	

2. PCB DETAILS

PCBs OF RECEIVER			
SL No.	PCB CODE	DIMENSION(mm)	DESCRIPTION
1	ISR-101	34X50	
2	ISR-302	98X59	
3	ISR-603	80X45	
4	ISR-404	95X62	
5	ISR-205	69.5X44	
6	ISR-106	69.5X44	
7	ISR-607	82X89.2	
8	ISR-509	82X57	
9	ISR-110	75X40	
10	ISR-211	60X50	
11	ISR-112	45X50	
12	ISR-013	68X30	
13	ISR-014	68X30	
14	ISR-115	50X40	
15	ISR-030	40X8	
PCBs OF LO			
1	ISL-101	42.25x65	
2	ISL-102	59x47.5	
3	ISL-203	71x36	
4	ISL-204	39.6x36	
5	ISL-105	65x37	
6	ISL-306	39.5x33	
7	ISL-107	40.75x59	
8	ISL-308	48.75x37	
9	ISL-209	102x61	
10	ISL-310	64x57	
11	ISL-211	58x44	

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AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-S-RX &
LO-01

Revision-00

Issue Date :14-07-17

S-BAND RECEIVER & LOCAL OSCILLATOR_ 01_SPECS _FORMAT

12	ISL-312	61x38.5	
13	ISL-113	33x9.5	



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-S-TX-01

Revision-00

Issue Date :14-07-17

S-BAND TRANSMITTER_01_SPECS_FORMAT

PROJECT	ALL IRS TYPE	PACKAGE CODE	STX-11/22
MODEL	FLIGHT	PKG. DIMENSIONS (mm)	191 x 169 x 25

PRODUCT DESCRIPTION:

This Transmitter works on 42V RAW Bus supply. Each S-Band transponder consists of a receiving and a transmitting system and can operate in either coherent or non-coherent mode. In the coherent mode of operation, the downlink carrier is derived by PLL technique from the uplink signal. Once the on board signal acquires and locks on to the ground transmitted carrier after a single sweep of the uplink carrier, a coherent drive is generated which serves as a source for the downlink carrier. In the non-coherent mode of operation, the downlink carrier is derived from an independent TCXO.

Selection of coherent / non-coherent mode of operation is by ground command. S-Band Transmitter downlinks the Spacecraft telemetry data to control stations in Phase modulated format.



S-Band Transmitter

1. ELECTRICAL SPECIFICATIONS:

1.	Raw Bus Voltage	MIN	28V
		MAX	42V
2.	Output Power	30 dBm (min)	
3.	Onboard losses	4 dB (typ)	
4.	Harmonics	< -30 dBc	
5.	Spurious	< -40 dBc	
6.	Frequency stability	± 2 ppm over -10 to + 50°C	
7.	Frequency settability	Within ± 10 KHz of the nominal value	
8.	Modulation frequency response (1dB)	300 Hz to 500 KHz	
9.	Downlink modulation index	1.4 rad (max)	
10.	Modulation parameter for Telemetry	Modulation format	PCM / PSK / PM
		PM indices HK data	0.7 rad
		PB / Dwell data	1.0 rad
		PSK subcarrier frequencies	HK RT data: 25.6 KHz at 1024 BPS. PB / Dwell data: 128 KHz at 16 KBPS for PB and 1024 BPS for dwell
11.	Modulation parameter for Ranging	Modulation format	PM
		Transponder group delay variation	± 100 nsec over -10°C to +50°C, signal strength variation of -90 to -50dBm & Doppler of ± 50 KHz correctable to ± 10 nsec.
12.	Weight	1.6 Kg	



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-S-TX-01

Revision-00

Issue Date :14-07-17

S-BAND TRANSMITTER_01_SPECS _FORMAT

2. PCB DETAILS

SL No.	PCB CODE	DIMENSION(mm)	DESCRIPTION
1	IST-124	60 x 40	
2	IST-320	88.5 x 32	
3	IST-303	32 x 32	
4	IST-004	55 x 30	
5	IST-005	67.5 x 30	
6	IST-006	35 x 30	
7	IST-107	80 x 60	
8	IST-008	30 x 8	
9	IST-009	70 x 30	
10	IST-210	45 x 30	
11	IST-211	30 x 10.5	



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SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

I4K_SPECS_FORMAT

PROJECT	GSAT-xx	PACKAGE CODE	PIP
MODEL	FLIGHT	PKG. (mm)	DIMENSIONS 270.6 mm x 247 mm x 442.1 mm

PRODUCT DESCRIPTION:

I4K TMTC Subsystem is based on CCSDS format. PIP (payload interface package) packages provide the TMTC requirements of I4K/I6K Payload systems & these packages can be tailored to meet the Payload requirements. PIP package contains both TMTC systems powered from common DC – DC converter. The Telecommand System in PIP package involves command distribution to payloads onboard the spacecraft during various phases of the mission. The Telemetry system accepts data from payloads and is sent through 1553 bus to core package.



1. TECHNICAL SPECIFICATIONS:

I4K TMTC PIP PACKAGE

I/P VOLTAGE	MIN	42 V
	MAX	70 V
Electrical Specification Telecommand Unit		
Command Capacity	<u>H/W commands</u>	
	Core packages:	
	No of on/off commands (5V & 28V)	1032 Approx
	Data commands	128 Commands
	<u>S/W generated commands</u>	
	No Auto controlled heaters	104
Electrical Specification Telemetry Unit		
INPUT specifications	Analog :-5V to +5V	
	Digital Bi-level Bits :0 or 5V	
	Switch status monitoring :Open or Close	
	Thermistor :10K Thermistor	
Weight	15kg	

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SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

I4K_ SPECS _ FORMAT

2. PCB DETAILS

CARD	PCB CODE	DIMENSION(mm)	DESCRIPTION
N	G11TMTC10-2-01	270.6 mm x 247 mm	1553 Controller card
M	G11TM10-1-02M	270.6 mm x 247 mm	TM acquisition card – PIP – Type1
L	G11TM10-1-02L	270.6 mm x 247 mm	TM acquisition card – PIP – Type1
K	G11TM10-1-02K	270.6 mm x 247 mm	TM acquisition card – PIP – Type1
J	G11TM10-1-02J	270.6 mm x 247 mm	TM acquisition card – PIP – Type1
I	G11TM10-1-04	270.6 mm x 247 mm	TM acquisition card – PIP – Type2
H	G11TC10-0-06H	270.6 mm x 247 mm	Dummy Tray
G	G11TC10-0-06G	270.6 mm x 247 mm	Dummy Tray
F	G11TC10-0-06F	270.6 mm x 247 mm	TC command Distribution - PIP
E	G11TC10-0-06E	270.6 mm x 247 mm	TC command Distribution - PIP
D	G11TC10-0-06D	270.6 mm x 247 mm	TC command Distribution - PIP
C	G11TC10-0-06C	270.6 mm x 247 mm	TC command Distribution - PIP
B	G11TC10-0-05	270.6 mm x 247 mm	Data Command card
A	G11TMTC10-0-50	270.6 mm x 247 mm	DC – DC Converter (TM &TC)



AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE

SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

I4K_ TYPE_TMTC

PROJECT	GSAT-xx	PACKAGE CODE	NTMTC-10 and 20
PKG. TYPE	FLIGHT	PKG. DIMENSIONS (mm)	284*230.2*297.6mm

PRODUCT DESCRIPTION:

I4K TMTC Subsystem is based on CCSDS formant. Package contains electrically isolated TM and TC subsystems in a single mechanical housing. The Telecommand System for I4K Spacecraft decodes the up-linked (transmitted) command & provides the command information and data in binary form for the operation of various subsystems onboard the spacecraft during various phases of the mission. The Telemetry system accepts data from various other subsystems within the spacecraft in either Analog or Digital form. The acquired data in serial PCM format is modulated on PSK sub-carrier, which are having appropriate band pass filter at its output to avoid interference with the Ranging tones.



I4K TMTC CORE PACKAGE

1. TECHNICAL SPECIFICATIONS:

I/P VOLATGE	MIN	42 V
	MAX	70 V
Electrical Specification Telecommand Unit		
Modes of operation	Clear mode and Encrypted & authenticated mode	
CCSDS Layers	Coding layer (in Single error correcting mode), Data link layer, Security layer, Segmentation layer.	
Input signal	Capability to Receive 5 sets of inputs.	
Input signal type	PCM – NRZ-L	
Command bit rate	500 BPS	
Command word length	32 bit	
Satellite ID	XXXX	
Command Capacity	<u>H/W commands</u>	
	Core packages:	
	No of on/off commands (5V & 28V)	400 Approx
	Data commands	Thro 1553

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SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

I4K_ TYPE_TMTC

	<u>S/W generated commands</u>	
	No. of time tagged commands	255
	No Auto controlled heaters	255
Minimum command/data uplink	4 octets (one command)	
Maximum command/data uplink	1000 octets (250 commands)	
Probability of spurious frame	2.58x10 ⁻²⁶ at BER of 10 ⁻⁵ when 1 command is sent	
	2.17x10 ⁻²² at BER of 10 ⁻⁵ when 250 command is sent	
Probability of frame rejection	3.9x10 ⁻⁷ at BER of 10 ⁻⁵ when 1 command is sent	
	2.87x10 ⁻⁵ at BER of 10 ⁻⁵ when 250 commands are sent	
Electrical Specification Telemetry Unit		
Bit rate	2.0Kbps	
Subcarrier frequency	32 KHz ,128KHz	
Transfer frame length	256 Octets	
Frame rate	1 s	
ASM (1A CF FC 1D)	32 Bits	
No. of frames	32	
Frame ID	5 Bits	
Number of Formats	Two	
	a)Normal Format	
	b) Dwell Format	
On board time	4 Octets	
INPUT specifications	Analog :-5V to +5V	
	Digital Bi-level Bits :0 or 5V	
	Switch status monitoring :Open or Close	
	Thermistor :10K Thermistor	
Output specifications	PCM-NRZ (S) – PSK to RF Transmitter.	
Weight (TMTC)	12.4kg	

2. PCB DETAILS

CARD	PCB CODE	DIMENSION(mm)	DESCRIPTION
A	G11TC10-0-03	284*230.2	TC COMMAND DISTRIBUTION
B	G11TC10-0-03	284*230.2	TC COMMAND DISTRIBUTION
C	G11TC10-1-01	284*230.2	TC core interface card
D	R1ATC10-1-02	284*230.2	TC core card
E	G11TC10-0-04	284*230.2	TC Heater card

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SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

I4K_ TYPE_TMTC

F	G11TC10-0-04	284*230.2	TC Heater card
G	G11TM10-0-03	284*230.2	TM acquisition card
H	G11TM10-0-03	284*230.2	TM acquisition card
I	G11TM10-2-01	284*230.2	TM core card
J	G11TM10-0-40	284*230.2	DC DC card

	AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE		
	SEG-TED-TMTC-01	Revision-00	Issue Date :14-07-17
	TMTC_SPECS_FORMAT		

PROJECT	IRNSS	PACKAGE CODE	TMTC-10 & 20
MODEL	FLIGHT	PKG. DIMENSIONS (mm)	284 x 217 x 216

PRODUCT DESCRIPTION:

IRNSS Telemetry and Telecommand (TTC-Base Band) system is developed using standard ASICs, HMCs and FPGAs that caters to spacecraft health monitoring through Telemetry and commanding for control during all the phases of the Mission. Telemetry system also provides Dwell mode facility along with normal telemetry. Dwell mode Telemetry and Normal mode facility are available from each TM simultaneously. Telecommand system incorporates CCSDS type of commanding scheme for generating all ON/OFF pulse commands and 16bit data commands. Telecommand and telemetry provide MIL1553 interfaces to other subsystems as per their requirements. The Telecommand processor provides autonomy features like programmable automatic temperature controller, Time tagged command, configurable

command block execution, safe mode operation and the like. It also does MIL 1553 scheduling. Telecommand system provides secure commanding feature by encryption and authentication. Telemetry and Telecommand systems are fully redundant except for command distribution units and are housed in two packages (TMTC-10 & TMTC-20) with one package mounted on South panel and another on the North panel.



TMTC-10 / 20

1. ELECTRICAL SPECIFICATIONS (TELEMETRY):

Frame rate	128 words/frame
Word format	8 bits/word
Bit rate	1Kbps
Frame Sync Code	24 Bits (AC CA IF)
Sub frame	32
Sub Frame ID	5 Bits (0 to 31)
On board time	32 bits (8 ms resolution)
Number of Formats:	1. Normal Format 2. Dwell Format (selectable)
Spacecraft id	8 bits
Inputs	
Analog	-5V to +5V
Normal (Digital) Bits	0 or 5V
Digital words	8 Bits

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	SEG-TED-TMTC-01	Revision-00	Issue Date :14-07-17
	TMTC_SPECS_FORMAT		

Switch status monitoring Thermistor 1553 Interface	Open or Close 10K Thermistor Transmitted Voltage: 18V – 27V Received Voltage: > 1.4V Rise time / Fall time: <300ns
Telecommand	ON/OFF commands : 5V or 42V, 64ms Level commands : 0V / 5V or 42V Data commands: Data: 16 bits, 1kbps CLK : 1kHz TP : 64ms
RMU Interface signals Clock ALE (Address Latch Enable) P/S (Mode Pulse) SA (Serial Address)	5V, 2kHz 5V, 250µs 5V, 500µs 0V / 5V
Delay Between Clock and ALE	8µs
Output signal	PCM-NRZ(S) , PSK 4Vpp ± 5%
Subcarrier modulation	PCM, PSK
Subcarrier frequency	32 KHZ, 128 KHZ
Transfer accuracy	1%
Supply Voltage	Min: 26V, Max: 42V
Package Power	≈ 13.5W
Package Weight (TMTC)	8.4kg

2. ELECTRICAL SPECIFICATIONS (TELECOMMAND):

Input signal	PCM – NRZ L
Command bit rate	500 bps
Format	CCSDS Type
Spacecraft address	10 bits (CCSDS SCID)
Command frame length	4 octets – 1000 octets
Commanding modes	(i) Clear mode

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	SEG-TED-TMTC-01	Revision-00	Issue Date :14-07-17
	TMTC_SPECS_FORMAT		

	(ii) Encrypted & Authenticated
MAP ID	Hardware commands : 05 Respective TCP : 06 [Dec1 to TCP1, Dec2 to TCP2] Other TCP : 07 [Dec1 to TCP2, Dec2 to TCP1] Both TCPs : 08 [Dec1 to TCP1 & TCP2] [Dec2 to TCP1 & TCP2]
Interfaces ON/OFF commands Variable Pulse widths Level commands Data commands Heater Commands 1553 commands	5V or 42V, 64ms 64ms, 128ms, 256ms, 512ms, 1024ms, 2048ms, 4096ms, 8192ms 0V / 5V or 42V Data : 16 bits, 1kbps CLK : 1kHz TP : 64ms 0V (OFF) or 42V (ON) Transmitted Voltage : 18V – 27V Received Voltage : > 1.4V Rise Time / Fall time : <300ns
No. of Receiver Interface	5
Telemetry	RMU Interface CLK : 2kHz Address Latch Enable (ALE) : 250µs Mode Pulse (P/S) : 500µs Serial Address (SA) : 0V/5V
1553 Bus	Payload Bus : TC - BC & P/L - RT AOCE Bus : TC – RT & AOCE - BC
No. of ON/OFF commands	404 (capacity 516)
No. of data commands	23 (40 capacity)
No. of TT commands, Time resolution and Range	255 Resolution 2s, 0-36 hrs.
No. of CCB commands	255
No. of auto controlled heaters	152
Spurious Command Probability @BER=10-5	3.9 X 10 ⁻⁷ at BER 10 ⁻⁵ for 1command 2.87 X 10 ⁻⁵ at BER 10 ⁻⁵ for 248 commands / 1000 bytes data

	AVIONICS PRODUCTION HARDWARE - ISRO SATELLITE CENTRE		
	SEG-TED-TMTC-01	Revision-00	Issue Date :14-07-17
	TMTC_SPECS_FORMAT		

Command Rejection Probability @BER=10-5	2.58 X 10 ⁻²⁶ at BER 10 ⁻⁵ for 1command 2.17 X 10 ⁻²² at BER 10 ⁻⁵ for 248 command / 1000 bytes data
Supply Voltage	Min: 24 , Max:42
Package Power	≈ 15W
Package Weight (TMTC)	8.4kg

3. PCB DETAILS:

CARD	PCB CODE	DIMENSION(mm)	DESCRIPTION
A	NTM10-E-802	244 x 201	RMU CARD
B	R1ATM10-0-01	244 x 201	CORE TM CARD
C	NTC30-5-05	244 x 201	PROPULSION & HTR I/F CARD
D	R1ATC10-2-02	244 x 201	CORE TC CARD
E	R1ATC10-1-01	244 x 201	CORE INTERFACE CARD
F	NTC10-2-09	244 x 201	DISTRIBUTION CARD
G	NTC10-8-02	244 x 201	RELAY INTERFACE CARD
H	R1ATMTC10-2-40	244 x 201	DC/DC CARD
I	R1ATMTC10MB-001	232 x 216	MOTHERBOARD



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SEG-TED-DOC-01

Revision-00

Issue Date :14-07-17

WIM_SPEC

PROJECT	GEOSAT	PACKAGE CODE	NCE-21, 22 & 23
MODEL	FLIGHT	PKG. DIMENSIONS (mm)	197*123.6*70

PRODUCT DESCRIPTION:

Wheel Interface Module is used to provide the interface compatibility between WDE and AOCE, TC, TM, Wheels with WDE designed, fabricated and supplied by TELDIX. AOCE has digital interface to get wheel speed, direction and on/off status and output torque control signals, since the interface between AOCE and WDE is not directly compatible, WIM is used to provide the interface compatibility between AOCE and WDE.



1. TECHNICAL SPECIFICATIONS:

I/P VOLATGE	MIN	26
	MAX	42.5
Bus Current	Supply voltage @ 28 V	45 ± 10 mA
	Supply voltage @ 42 V	30 ± 10 mA
Digital status signal	4.5 V to 5.5 V	
Expected Offset for Moter Current interface	±250 mV	
Weight	0.960kg	

2. PCB DETAILS

CARD	PCB CODE	DIMENSION(mm)	DESCRIPTION
A	NCE 21-0-01	101.6*152.4	WIM card
B	NCE 21-0-02	60*18	Filter card

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